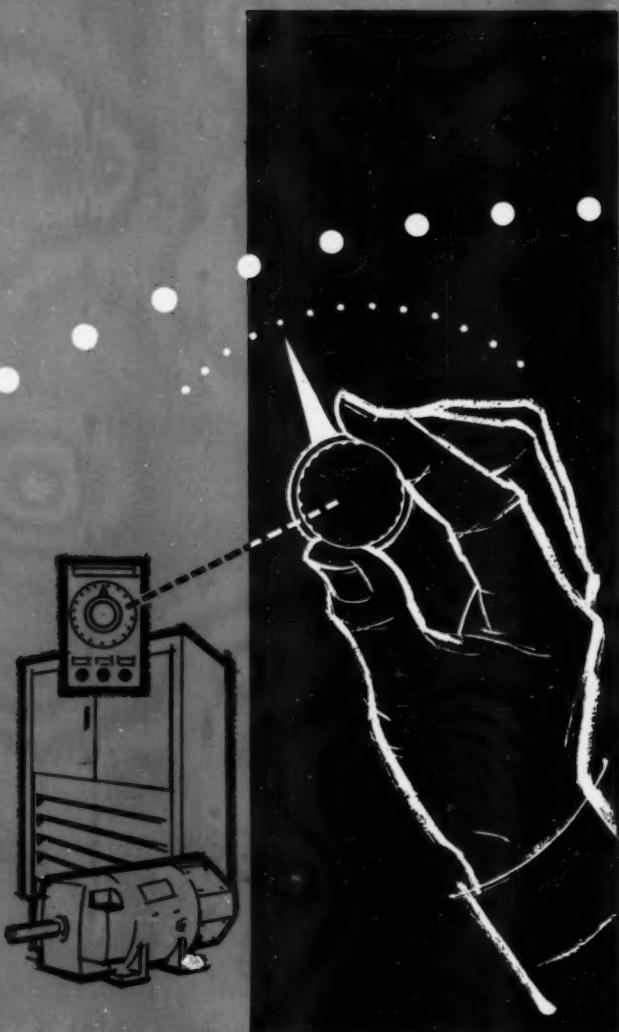


# POWER TRANSMISSION DESIGN

NOVEMBER 1959

OEM · MAINTENANCE



## Special Report: **Electrical Adjustable Speed Drives**

THE MAGAZINE OF MACHINE DRIVES



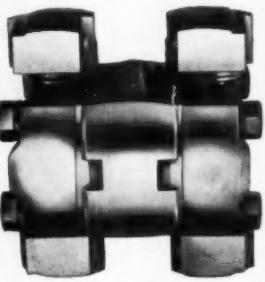
***News and Ideas for designers and plant engineers  
who use power drive equipment***

If you are faced with the problem of locating a universal joint in a space where limited clearance does not permit the use of a flanged joint, MECHANICS close-coupled Roller Bearing UNIVERSAL JOINT is your solution. This joint is specially designed for operation within cramped quarters that engineers formerly considered too short to accommodate a universal joint.

Where starts, stops and reverses are frequent—loads heavy and torque requirements severe—amid dust and moisture—MECHANICS Close-Coupled, Roller Bearing UNIVERSAL JOINTS serve dependably, safely and economically. They transmit more power—in less space—at greater angles than any other joints.

Unique features of MECHANICS Roller Bearing UNIVERSAL JOINTS make them unusually easy to install and service. The complete cross and bearing assembly can be removed simply by taking out the cap screws and separating the end yokes slightly. No flange is required for drive shaft connections. Accurately and durably built for long, heavy service, MECHANICS Roller Bearing UNIVERSAL JOINTS are inherently balanced for smooth operation.

Modern Crawler tractor design requires a F-L-E-X-I-B-L-E connection between the engine and transmission. MECHANICS Close-Coupled Type UNIVERSAL JOINTS not only provide

IF  
LIMITED  
SPACE  
IS  
YOUR  
PROBLEM  
*Specify*  
  
CLOSE  
COUPLED

for high angularity within cramped space but compensate for out-of-alignment conditions. The shocks and strains that crawler tractors encounter in heavy duty work often are so great that they temporarily twist the tractor frame. MECHANICS Close-Coupled Type UNIVERSAL JOINTS are designed to provide the F-L-E-X-I-B-L-E needed to make efficient operation possible under such adverse conditions. MECHANICS exclusive KEY method of driving has the highest safety factor, transmits the most torque, and averts costly breakdowns that result from driving through bolts or screws that work loose.

MECHANICS key-drive strength, flexibility and balance are unanimously specified by the largest tractor manufacturers to keep huge capacity machines operating long hours, day-after-day. They can't afford to permit large tractors and equipment to be kept idle by needless down-time. Let MECHANICS engineers help build reliability into your (200 to 50,000 foot pounds torque capacity) machines.

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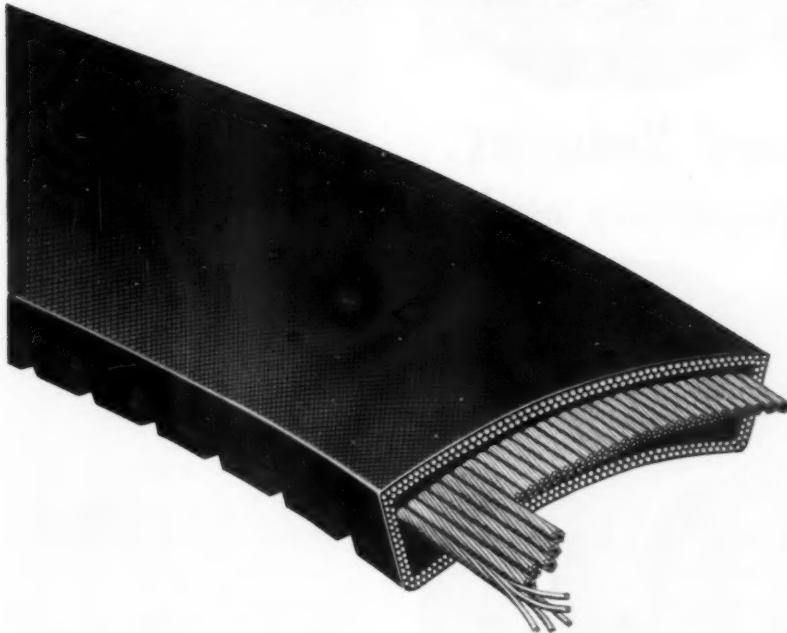
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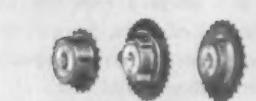
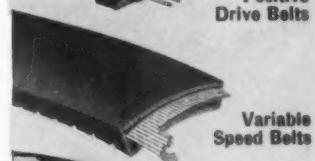
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to the peak of efficiency



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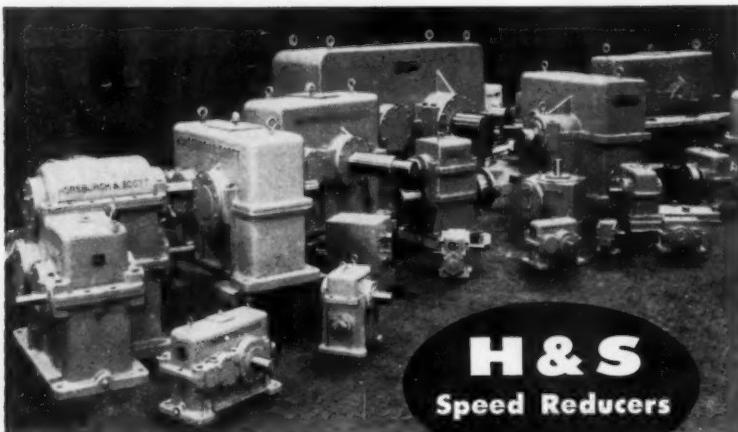
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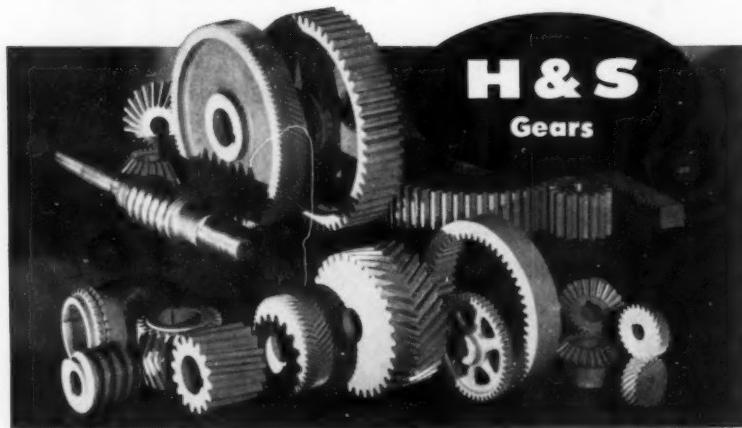
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GEARS AND SPEED REDUCERS  
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2

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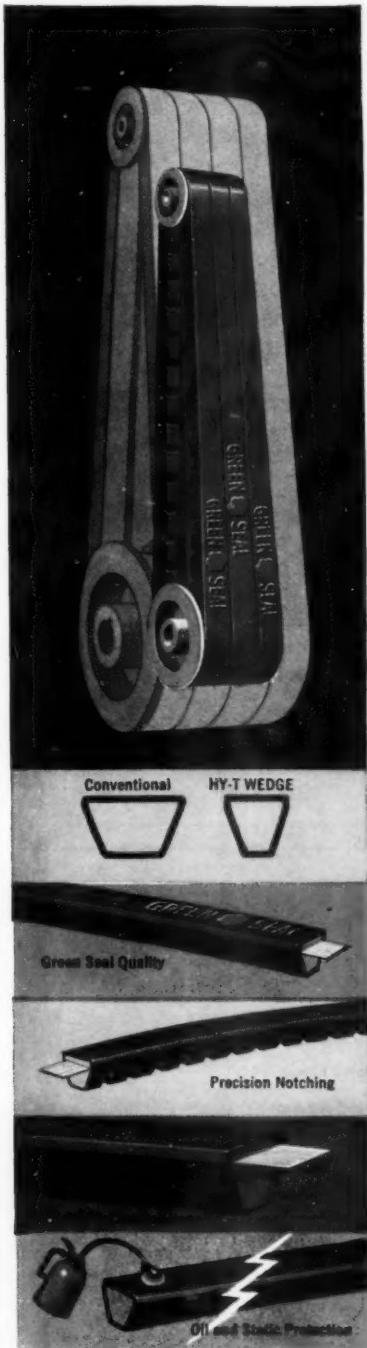
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It's just what you'd expect from the Goodyear specialists who pioneered and patented the first wedge-type V-Belt in '48!

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And HY-T WEDGE gives you—without extra cost—built-in protection against oil attack and static electricity build-up.

Here, then, in the HY-T WEDGE, you have a new kind of V-Belt to handle the toughest belting jobs with smaller, more efficient drives—at never-before low cost.

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GREEN SEAL BY

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NOVEMBER 1959

Volume 1 number 11

# POWER TRANSMISSION DESIGN



THE MAGAZINE OF POWER TRANSMISSION

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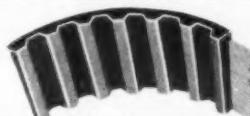


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## DA 358 V-BELTS



For highly compact, plus-power drives. First major design change in Multiple V-Belts in the last 30 years.



## DA POSITIVE DRIVE BELTS

Combines the advantages of the chain and gear with all of the advantages of the belt. No stretch, no metal to metal contact, no constant lubrication.

## STURDI-LINK

Pre-stretched link belting available in regular, oil-resistant and static-conductive types.



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Power-balanced construction for flexibility, durability and strength.



## STEEL CABLE V-BELTS

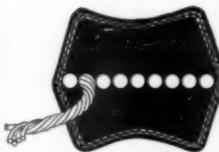
Steel cable permits no-stretch installation. All belts are fluoroscoped to assure extra high quality.



## RAILROAD BELTING



High tensile strength, low stretch belting features high fastener tear-out resistance.



## DOUBLE V-BELTS

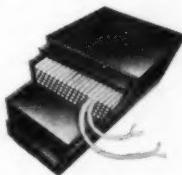
Relieved cross section assures maximum flex resistance. New control methods provide uniform cord section.

## OPEN END V-BELTING



Used on drives where endless V-Belts are not practical. High fastener tear-out resistance.

## RED SHIELD MULTIPLE V-BELTS



Red Shield Belts now offer 40 per cent extra capacity. Iso Dynamic matching and cord stability assure precise balance and long belt life. Also available in oil and heat resistant and static dissipating constructions.

## VARIABLE SPEED BELTS



Abrasion resistant cover assures maximum life. Crowned cross section maintains stability under extreme loads.

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## MEN of the power transmission industry



Van Dorn



Potter



Jones



Patterson

### Fafnir appoints four to executive posts

NEW BRITAIN, CONN.—Four major appointments in the product engineering division of the Fafnir Bearing Co. were recently announced.

Horace B. Van Dorn was appointed director of engineering, a new post. With Fafnir since 1937, Van Dorn was formerly technical development manager.

Howell L. Potter was named assistant director of engineering. He

joined Fafnir in 1934, serving as chief engineer since 1949.

Francis G. Patterson was appointed chief product engineer. He was formerly assistant chief engineer in charge of research.

A. Burton Jones, Jr., was made chief research engineer. Jones has been with Fafnir since 1950, and was previously director of research and development for the Marlin-Rockwell Corp.

### Department manager at Minneapolis-Moline

HOPKINS, MINN.—Robert B. Singer has been named manager of the experimental department of the engineering division of Minneapolis-Moline Co., according to James A. Miller, director of engineering. Singer was formerly research and development engineer for the Dana Corp., Toledo.

His experience includes work in the development of new transmissions for Clark Equipment Company and Warner Gear Division of Borg-Warner Corp. At Dana he developed new products in the areas of axles, frames, clutches, universal joints, transmissions and drive shafts, including components for aircraft drives.

Miller, now engineering director for Minneapolis-Moline, is also a relatively new member, having



Singer

joined the company last June. He has been a transmission designer for such companies as Ford Motor Co., Borg-Warner Corp., and Clark Equipment Co.

Minneapolis-Moline is a prominent manufacturer of farm and industrial machinery.

### U.S. Rubber names two division chiefs

NEW YORK, N. Y.—Matthew J. Delehaunty was recently named market planning manager for the mechanical goods division of the United States Rubber Co. At the same time, the appointment of Henry Davis, Jr. as field sales manager of the same division was made known.

Delehaunty, who relinquished the field sales manager post to Davis, has been in the rubber industry for 48 years, 31 of them with U. S. Rubber.

Davis was formerly Eastern regional manager for the division, operating from the company's Baltimore branch. He joined the company in 1945, and has served in the Buffalo, Atlanta, Baltimore and Pittsburgh branches. Both Delehaunty and Davis will now operate from the company's New York offices.

## **Lord names Henshaw operations manager**

ERIE, PA.—Richard C. Henshaw has been named manager of operations at Lord Manufacturing Co., producer of engineered systems for vibration, shock and noise control.

Henshaw assumes responsibility over the engineering, manufacturing and marketing divisions.

## **Leece-Neville names Marohn vice president**

CLEVELAND, OHIO—James A. Marohn, formerly vice president of the Crane Company, Chicago, became executive vice president of Leece-Neville Company, Cleveland, last month.

Leece-Neville manufactures motors, starters, generators and other electrical equipment in the automotive, marine, aircraft and general industrial fields.



Schwenker

## **Schwenker becomes PIC vice-president**

EAST ROCKAWAY, N. Y.—PIC Design Corp., manufacturer of stock precision instrument gears and servo components, has announced the appointment of Rowland F. Schwenker as vice-president and general superintendent.

Schwenker is one of the principal founders of PIC and has spent the last twenty-five years in the precision gear and component field.

*Continued on page 50*

### **GEARBELT ADVANTAGES:**

- **A POSITIVE DRIVE.** No slip, creep or backlash.
- **STEEL CABLE** strength member will not stretch, needs minimum take-up.
- **FREEDOM** from high initial belt tension. Reduces bearing loads, increases life.
- **COMPACT.** Gearbelts permit smaller pulleys, shorter centers, narrower belts.
- **LIGHTWEIGHT.** High horsepower-to-weight ratio.
- **LESS NOISE.** No vibration, no chatter.
- **LESS HEAT** because virtually no friction.
- **SPLIT TAPER BUSHING** grips pulley on shaft with vise-like pressure. Quick, easy mounting and removal.

Here is a versatile new drive that provides high mechanical efficiency *plus* the inherent flexibility of belts. Browning Gearbelts engage matching pulleys with the positive action of gears, yet without their disadvantages. They eliminate metal-to-metal contact, lubrication, vibration, chatter. Require minimum maintenance.

Browning Gearbelt Drives provide cost-saving advantages in scores of applications, particularly those which require high capacity in limited space, or freedom from stretch and take-up. Ask your Browning distributor for complete information, or write us for Catalog GB-201.

**Browning Manufacturing Company  
Maysville, Kentucky**

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**CROFTS**  
**'Ritespeed'**

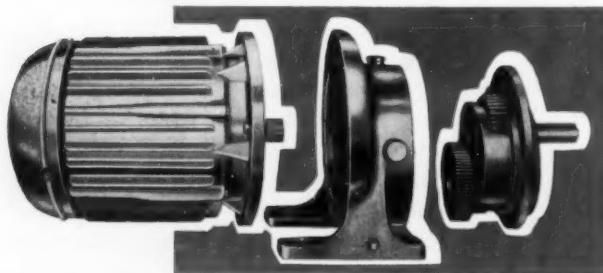
**GEARMOTORS AND GEAR REDUCERS**

## **— REAL DEPENDABILITY FOR LESS MONEY!**

**Fact:** It costs substantially less to buy Crofts Ritespeeds than comparable quality drives.

**Fact:** Crofts Ritespeeds have earned an enviable world-wide reputation for dependable performance.

Coupled, these two facts give you the greatest value in gearmotors and gear reducers. Quiet-running Crofts Ritespeeds mount in any position, are built to give maximum operating economy, lasting service. Gears are precision cut from high tensile steel. Shafts are mounted on anti-friction bearings. Rugged gear cases are made from Crofts Semi-steel.



*Send us your requirements now for recommendations and prices. Bulletin B-5828 gives details about gear reducers. Bulletin B-5829, about gearmotors.*

Crofts Ritespeed gears are replaceable as a unit "cartridge", saving labor and downtime. Crofts maintain an immediately-deliverable stock of gear "cartridges" and cases, electric motors and bearings.

Available from stock up to 15 h.p. Made to order up to 80 h.p., ratios up to 82:1.

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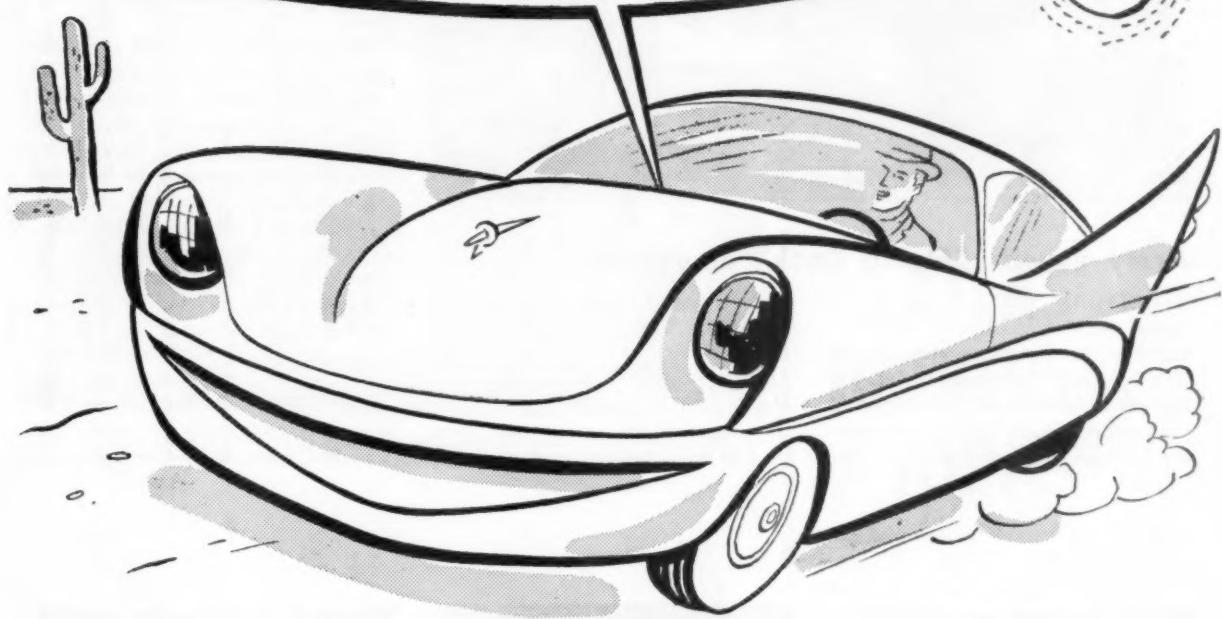
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from the POWER UNLIMITED complete belt line

I'M COOL MAN, COOL



The U. S. Auto AirCon Steel Cable V-Belt has everything required in a belt for air-conditioning use. Here is a V-belt that's in a class by itself. It is equipped with pulling cords of steel. A new patented curing method and electronic tensioning of the steel cords *free this belt from vibration*. It transmits power smoothly, quietly and efficiently—in present automotive air-conditioning service, lasts 1½ to 2½ times longer than any other V-belt. Here are the unequalled advantages the engineers point out:

- All steel cable members lie in the same plane.
- Wire cable members are straight, never wavy.

- Absolute uniform top width and belt thickness for better seating in pulley.
- Perfect dynamic balance.
- Use of knurled mold insert provides maximum traction and alignment of outside idler.

Our field engineers stand ready to consult with you on any or all V-belt problems. Drop us a line at address below.

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Mechanical Goods Division

**United States Rubber**

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## NEWS from the power transmission field



### Army unveils "Flying Duck" amphibian

STRATFORD, CONN.—The U. S. Army, seeking increased mobility, has announced its latest concept, the "Flying Duck"—a truck that floats like a boat and flies like an airplane.

Developed by Avco Corp.'s Lycoming Division, it is a gas turbine pow-

ered, hydrofoil version of the DUKW of World War II, an amphibious landing craft widely used in both the European and Pacific theaters. The Duck, flown successfully for the first time less than two months ago, uses its 860 hp Lycoming engine, which

normally powers helicopters and airplanes, in combination with aerodynamically-shaped hydrofoil wings to attain water speeds up to 50 miles per hour. It weighs 26,000 pounds.

On water, the Duck begins operations like a conventional boat. But when it reaches a speed of five miles per hour the water flowing around the hydrofoil wings extended below the surface acts like air flowing past an airplane wing. The pressure above the foil is reduced relative to the pressure below, resulting in lift. At thirteen miles per hour, this lift is enough to raise the vehicle well out of the water. At full speed, the hull is more than four feet above the surface.

With the hull completely out of the water, more than sixty percent of the drag is eliminated, allowing a tremendous increase in speed. The Duck's ability to sustain high speeds over long rough-water hauls is its greatest single advantage, according to the Army Ordnance Corps. Moreover, an automatic pilot senses the waves ahead and controls the foils to compensate for any variations, even in very rough water.

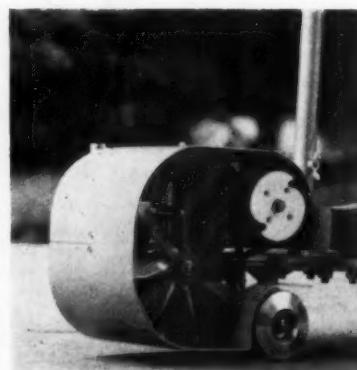
In addition to water speed of 50 miles per hour, the vehicle can operate for five hours with a range of 250 miles. Ordinarily it would be launched from a "mother" ship on

### Novel pedestrian vehicle wins ALCOA award

PITTSBURGH, PA.—You can really get about on the "Skeeter," a unique design for a minimum pedestrian transportation vehicle by Louis Richards, an industrial design student at the Illinois Institute of Technology. Richards' project won one of five national awards given industrial design students by Aluminum Company of America.

Scooter-type vehicle was designed as part of a project to investigate simple transportation techniques. It is an 18-inch-long aluminum platform, wide enough for both feet. It has a small motor enclosure at the front, topped by a slender vertical rod-like handle, and mounted through gaskets on pivoting axles.

It is powered by a .6 cu in. displacement model airplane engine,



which runs about 10 minutes on three ounces of fuel, and which is geared to give between 4 and 12 miles per hour. The rider starts the engine by pushing off with one foot. Stopping is accomplished by decelerating and stepping off. Rider steers by leaning in the desired direction. Turning circle is four feet in diameter.

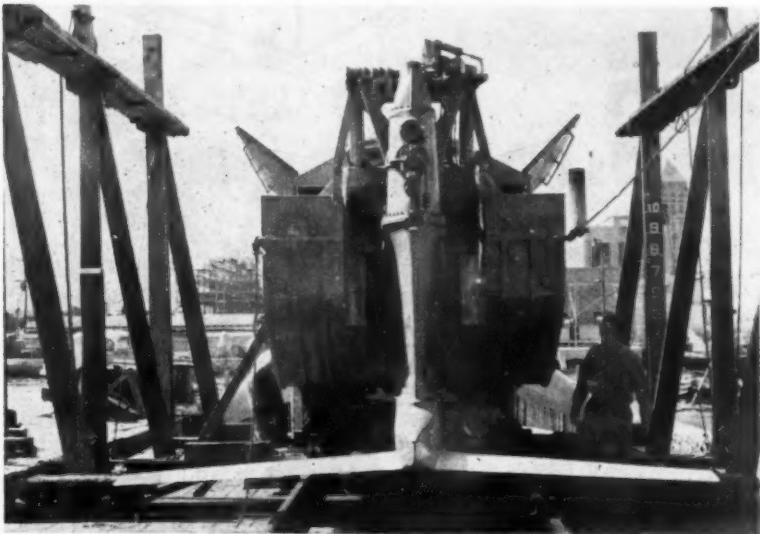
### Western Gear sales outlet

LOS ANGELES, CALIF.—Western Gear Corp., Los Angeles, has named the Harvey John Readey Co. of Whitehaven, Tenn., as its representative for StraitLine gearmotors, Straitline speed reducers and SpeedMaster reducers and high-speed units. The Readey territory covers Arkansas and parts of Mississippi and Tennessee.

### Acton opens western office

ACTON, MASS.—Acton Laboratories, Inc. has a new sales and engineering office on the west coast. Located in Los Angeles, and under the management of William Purdy, it will provide factory engineering and sales service on the lines of precision drives, phase and impedance meters, vacuum tube voltmeters, oscillograph recorders and other equipment.

the high seas. All branches of the military may find uses for it, including anti-submarine patrol, air-sea rescue duties, a mobile missile-launching platform, a platform for frogmen, a coastal patrol craft, and a means for retrieving nose cones and space capsules out of the sea. One obvious use is for amphibious invasions which would allow the transporting of cargo and troops from 100 miles



**REAR FOIL** is normally thirty inches below surface of water. Both strut and foil are retractable. Flying Duck is shown in drydock at Miami Shipbuilding yard.

**Entries accepted for 1959  
Minaturization Awards**

KEENE, N. H.—Nominations for the 1959 Miniaturization Awards Competition are now being accepted, according to Horace D. Gilbert, chairman of the Awards committee and president of the sponsoring group, Miniature Precision Bearings, Inc.

The Award is presented annually in recognition of outstanding contributions to the advancement of the field of miniaturization. Ten Certificates of Excellence are also given each year.

Individuals, companies or organizations may qualify by 1) broadening the horizons of miniaturization by creating better understanding and use of miniaturization through education, research, engineering or standardization; or (2) developing products, components or assemblies that show ingenuity in the solution of

out at sea to inland areas in two hours, and with unusual mobility and self-defensive flexibility.

Much of the Flying Duck program was performed by Miami Shipbuilding Corp., under subcontract to Lycoming. The test program so far has been jointly conducted off the Miami coast. Advanced engineering and hydrodynamic studies were done at Stevens Institute of Technology.



*Save \$ \$ \$ \$*

# **ATLAS UNIVERSAL JOINTS**

Balanced to operate without vibration at all speeds. Short, stubby jaws give maximum resistance to spread. Larger diameter joints fitted with big grease reservoir. Standard alloy steel joints in fifteen sizes for all requirements. Also made in Bronze, Monel and other special metals.

**Universal Slip Shafts a specialty.**

**WRITE** for illustrated catalog giving  
data and specifications.

## **WEST COAST REPRESENTATIVES**

**LINK-BELT CO.**

**Los Angeles** **San Francisco**  
**Portland** **Oakland**

**THE  
GRAY & PRIOR  
MACHINE CO.**

**Circle No. 20 on Reader Service Card**

# Do-It-Yourself...

## Let's design a speed reducer today

**S**o you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

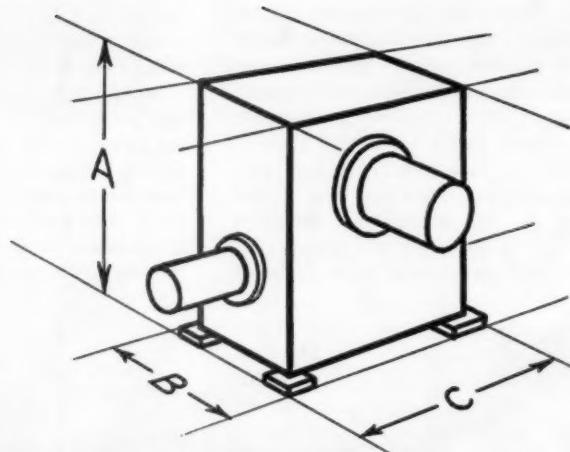
Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You



can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

For more information circle No. 10 on Reader Service Card

NOVEMBER 1959 / POWER TRANSMISSION DESIGN

For More Information Circle No. 6 on Reader Service Card.

## LETTERS

Address letters to:  
The Editor  
Power Transmission Design  
812 Huron Road, Cleveland 15, Ohio

### Suggestions

Gentlemen:

We receive your magazine, POWER TRANSMISSION DESIGN, and find it very informative and useful, particularly the bearing section and the reference file which we save. The magazine is excellent even now, but we would like to suggest a few improvements which we feel would make the articles easier to read and easier to use for reference. They are: 1) Start feature articles on right hand pages; 2) Make articles continuous; 3) Mark ends of articles; 4) Perforate pages for 3-ring binder.

ANDREW BODNAR, Staff Engineer  
John A. Roebling's Sons Division  
The Colorado Fuel and Iron Corp.  
Trenton, N. J.

### Reprints

Please forward to us one reprint each of the following articles appearing in the September 1959 issue of POWER TRANSMISSION DESIGN: "A Roller Bearing Carries Higher Loads Longer," and "Design and Application of Belts, Chain and Gears."

M. RITTER  
Farm Equipment Research and  
Engineering Center  
International Harvester Co.  
Hinsdale, Ill.

Would you please send us 75 copies of the article in your September 1959 edition titled "Bearings—Design and Application" which runs from page 42 through page 53.

I would also like 50 copies of the article on page 26 and page 27 titled "Hydrostatic Bearing Makes Large Load Float Freely."

These are two very good articles and you are to be complimented on them.

J. F. OEHlhoffen  
Vice President  
The Kaydon Engineering Corp.  
Muskegon, Mich.

## Take Your Pick OF THESE BROOK A.C. MOTORS



THE Open Drip Proof NEMA Rerate Motor occupies less space—weighs 12 to 15% less than the Open Drip Proof Motor in the old frame. This is no case of "Riding horse versus draft horse"—both motors have equal stamina. Some prefer the old frames, especially where space is no factor. Brook warehouses coast-to-coast carry both types in stock. You can't find a better motor at any price, yet Brook Motors cost substantially less, because of volume production, modern techniques, world-wide distribution and a realistic pricing policy. Brook Motors available from 1 to 600 H.P. All standard enclosures. Write for literature and name of your Brook Dealer.

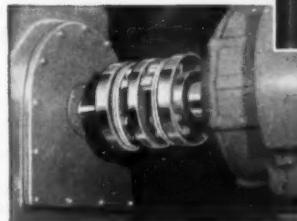
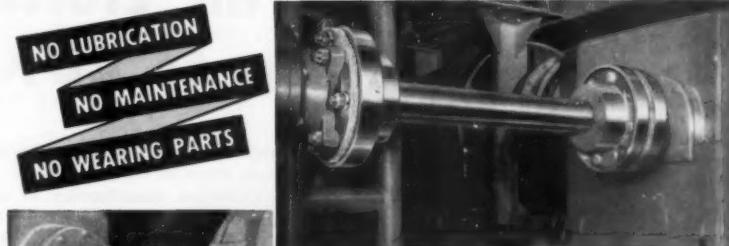
*world's most respected motor*  
**BROOK MOTOR CORPORATION**

3302-04 W. PETERSON AVE., CHICAGO 45, ILL.

In Canada: Brook Electric Motors of Canada Ltd.,  
250 University Ave., Toronto, Ont.



## For Power Transmission Without Maintenance Use **THOMAS FLEXIBLE COUPLINGS**



Thomas' 40 years of flexible coupling experience is at your disposal to help you meet ordinary applications or special variations for unusual cases.

Under Load and Misalignment only Thomas Flexible Couplings offer all these advantages:

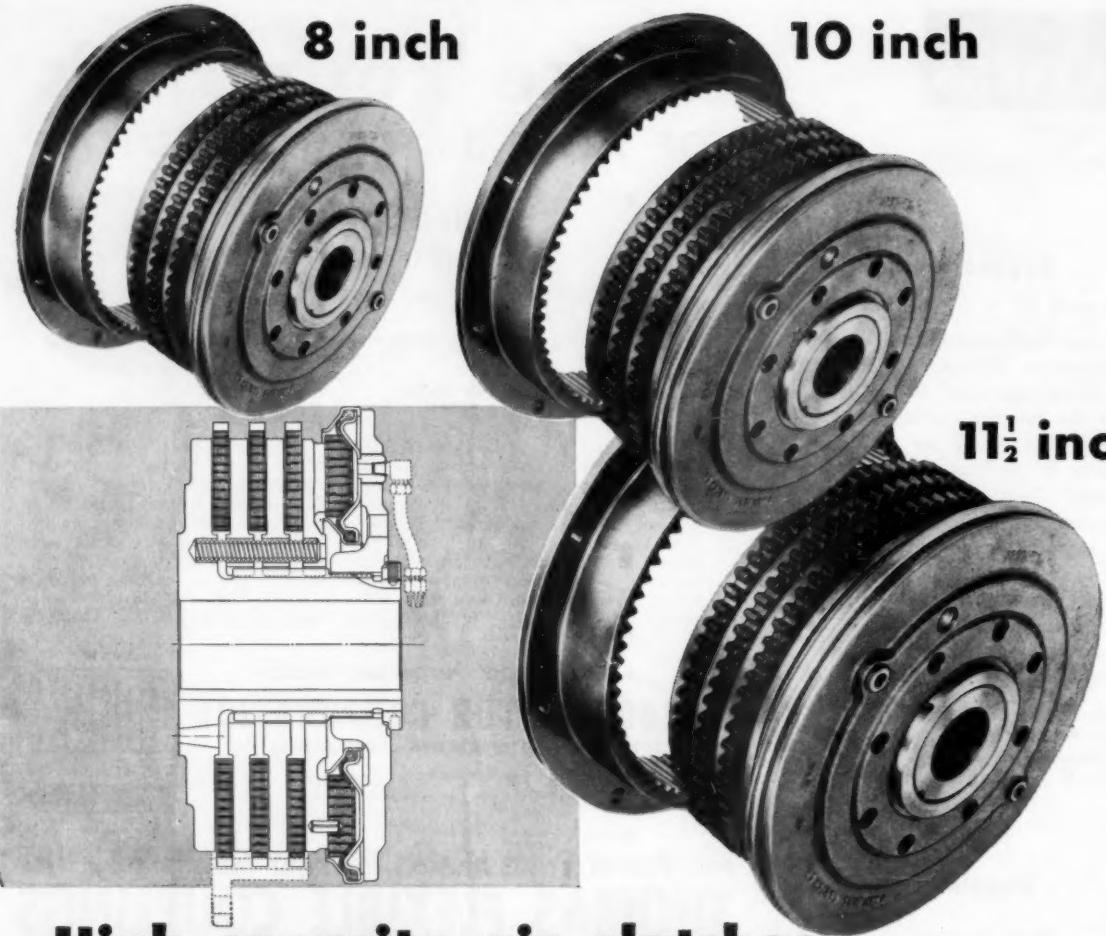
- 1 Freedom from Backlash Torsional Rigidity
- 2 Free End Float
- 3 Smooth, Continuous Drive with Constant Rotational Velocity
- 4 Visual Inspection While in Operation
- 5 Original Balance for life
- 6 No Lubrication
- 7 No Wearing Parts
- 8 No Maintenance



Write for engineering catalog 51A, and the name of your nearest Thomas representative

**THOMAS FLEXIBLE COUPLING COMPANY**  
WARREN, PENNSYLVANIA, U.S.A.

For more information circle No. 37 on Reader Service Card



## High capacity air clutches

... up to 40% less in cost

Having clutch problems? ... Then try the new low-cost Twin Disc 8, 10 and 11½-inch PO Air Clutches. You'll find in these new clutches all the quality and dependability associated with the entire PO Air Clutch line—*plus these important benefits:*

- New design permits highest capacity at up to 40% less cost than comparable remote-controlled units.
- Torque capacities to 3480 lb.-ft.
- Available in triple-plate, double-plate and single-plate construction.
- Exclusive cartridge-type reinforced neoprene diaphragm eliminates leakage ... provides longest life.
- Constant torque capacity without adjustment ... self-compensating for wear.

• Narrow width permits replacement of old-style drum or band clutches ... without extensive modification or redesigning.

• Suitable for air systems up to 130 pounds per square inch.

These new PO Air Clutches are adaptable wherever the convenience of remote air control is desired. They already have proved themselves in such heavy-duty applications as rock crushers, tractor winches, pipe-extruding machines, drilling rigs, machine tools, pug mills and other industrial equipment.

Addition of the new clutches extends the Twin Disc PO Air Clutch

line from 8 to 36 inches in diameter ... to 127,100 lb.-ft. in torque capacity. There's a PO Clutch for virtually every application requiring convenient remote control for connecting and disconnecting power. Write Twin Disc Clutch Company, Racine, Wis., for complete details.



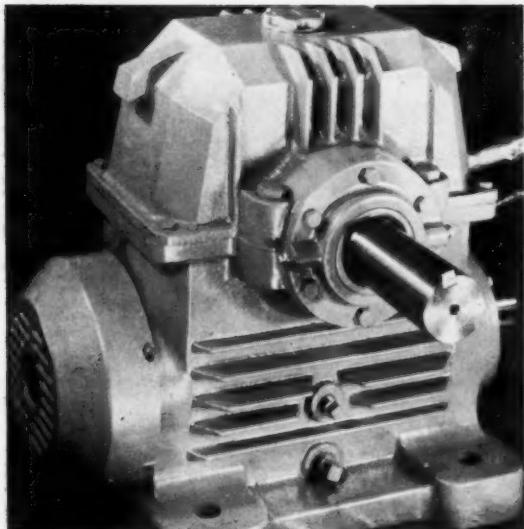
**TWIN DISC**  
Friction Clutches and  
Fluid Drives

**TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois**

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • LOS ANGELES • NEWARK • NEW ORLEANS

For more information circle No. 38 on Reader Service Card

## NEW PRODUCTS

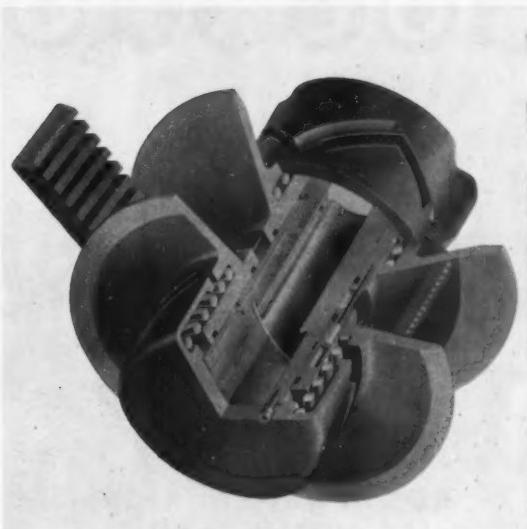


### Fan-cooled worm reducers

Compactly engineered unit has a single-wall, finned-construction case that fits closely over rotating parts. Gear material, centrifugally cast phosphor bronze, gives better mechanical strength and wearing properties and a lower friction coefficient. Fan-cooling prevents thermal problems by better balanced mechanical and thermal ratings, derived so that temperature increase above ambient normal is never greater than 100 deg F. Fan provides motion of air, crucial in heat dissipation in the higher speed range. It functions in either direction of rotation. Units come in complete ratio range with hp capacities from .1 to 150. Horizontal models in bottom drive (worm under gear) and top drive (worm over gear).

*De Laval Steam Turbine Co., Trenton, N. J.*

**Circle No. 200 on the Reader Service Card**



### Motion control sheave

New variable-speed sheave holds a constant driven speed under changing torque loads. No matter how long the sheave has been running at a set speed, it will not stick when speed is changed. Cam pressure is exerted only when load requires it. Power is transmitted equally to both movable flanges by resilient rubber cam followers. Grip on the belt increases with load, so pitch diameter is maintained and driven speed is kept constant. Cam followers allow continuous rotational oil pumping action of the flange hubs on the sleeves. MCS drive sheave comes in two sizes. One, for motors of 7½ to 15 hp, has pitch diameter range of 5 to 10 in. The other, for motors of 15 to 20 hp, has pitch diameter range of 6 to 12 in.

*T. B. Wood's Sons Co., Chambersburg, Pa.*

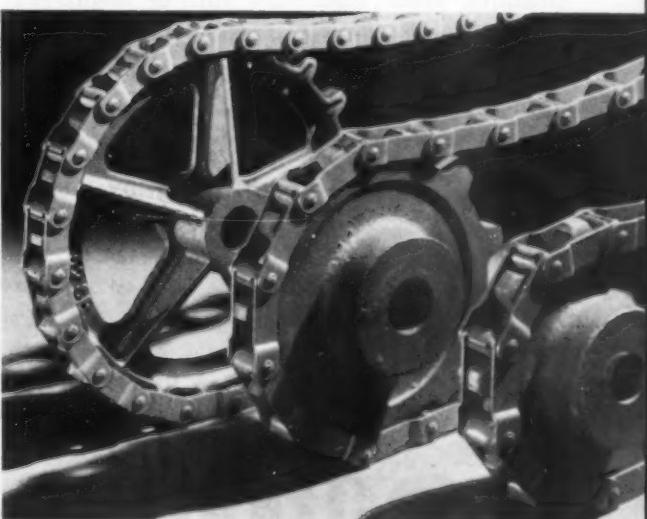
**Circle No. 201 on the Reader Service Card**

### Low-cost steel pintle chain for higher capacities

New type of steel pintle chain now in production should prove valuable in a wide variety of industrial and agricultural machines and equipment. The 600 series has the cost advantages of automatic-formed pintle chain but is meant for situations where adverse operating conditions, low maintenance requirements or use with cast sprockets are factors. It is well suited to applications requiring capacities greater than those of steel detachable chain and where more costly roller chain or malleable pintle chain would ordinarily be needed. Produced in four sizes—662, 667, 667-H and 672, to standard steel detachable chain pitches—600 chain is formed to close dimensions and uniform pitch from high-tensile, heat-treated steel. It has had two years of testing and is now in use in several farm equipment applications.

*The Locke Steel Chain Co., Huntington, Ind.*

**Circle No. 202 on the Reader Service Card**



# ROCKFORD



## ROCKFORD CLUTCHES WITHSTAND THE MOST SEVERE SERVICE

Severe Service is possible only through specialized equipment and highly practiced skills—the same as lie behind the quality of every ROCKFORD CLUTCH. Each order is given the extra measure of care that makes ROCKFORD CLUTCH quality a byword in industry. Due to rigidly held specifications covering the chemical analysis of materials, and properly governed heat treatment, the pressure plates used in ROCKFORD CLUTCHES withstand the most Severe Service. The plates are made from superior quality materials of more than adequate tensile strength. Heat treatment further improves the grain-structure and strength of the iron. We urge your engineers to consider this and other advantages of ROCKFORD CLUTCHES—when designing your next application of a clutch.



### SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

### ROCKFORD Clutch Division BORG-WARNER

1331 Eighteenth Ave., Rockford, Ill., U.S.A.

Export Sales: Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

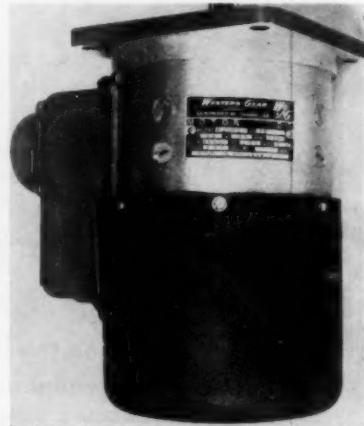
# CLUTCHES

For more information circle No. 32 on Reader Service Card

CONTINUED from preceding page

### Motor for actuator use

26v dc 1-3/4 hp compound wound reversible motor has 10,500 rpm top speed. Motor is compact (7 in. long,



4 in. dia.), meets requirements of MIL-M-H609A.

*Western Gear Corp., Electro Products Div., Pasadena, Calif.*

Circle number 203 on reader service card

### Miniature actuators

Electro-mechanical line is suitable for applications requiring rotary and linear motion. Powered with either ac or dc motor. Low backlash, accurate positioning, adjustable limit



Small  
Spring Loaded



Automotive  
Spring Loaded



Heavy Duty  
Spring Loaded



Oil or Dry  
Multiple Disc



Heavy Duty  
Over Center



Light  
Over Center



Power  
Take-Offs



Speed  
Reducers



switches, non-reversible gear train and brake if required. Meets MIL-A-8064A and MIL-E-5272A requirements.

*Nash Controls, Inc., Newark, N. J.*

Circle number 204 on reader service card

### FOR QUICK ACTION . . .

for more information on any new product items on these pages, use Reader Service Card opposite page 64. Just circle number or numbers you want, fill out Card and drop it in the mail. We'll do the rest.

Continued on page 30



*Announcing Worthington QD Sheaves with the*

# GOLDEN SCREWS

To demonstrate to you that the exclusive two-screw design is practically worth its weight in gold, all Worthington QD (Quick Detachable) sheaves now have two golden screws.

The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves one part at a time. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another

sheave on the hub which remains anchored to the shaft by the clamp screw.

The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

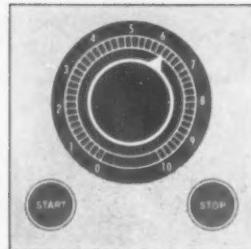
You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

You can get Worthington QD sheaves anywhere in the U.S. More than 350 dis-

tributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pennsylvania. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.



*For more information circle No. 44 on Reader Service Card*



A twist of the dial . . . . .

For extra free copies  
of this 12-page article,  
circle number 300 on  
Reader Service Card.

## Adjust your speed, any speed,

### What is an electrical adjustable speed drive?

An adjustable speed drive consists of a drive motor, a control and an operator's controller—or more than one of each. Some drives are all a-c, some are d-c and some convert a-c to d-c.

The a-c/d-c conversion-type drive is probably the best known since a-c power is universal throughout industry and is converted for use on d-c motors which have good speed-control characteristics. A-c drives,

however, are becoming increasingly popular and have many advantages; no d-c conversion is accomplished.

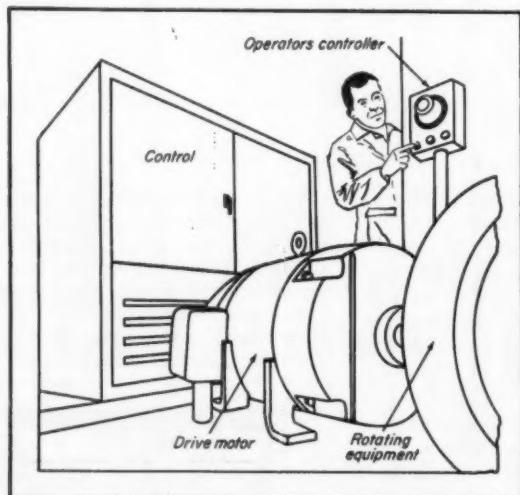
In an a-c adjustable speed drive, a wound-rotor a-c drive motor is usually used. In a d-c drive, a shunt-wound d-c drive motor is usually used. Other types of motors can be used, and in some drives, a combination of the two is employed.

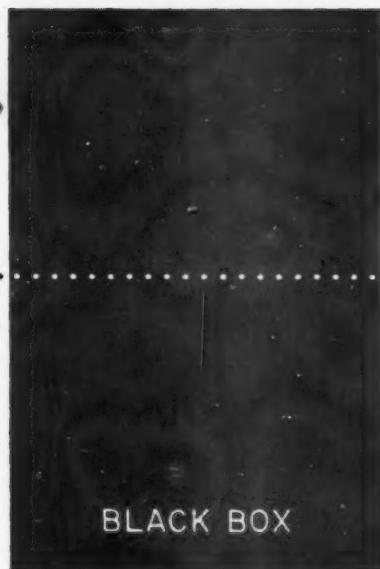
The control contains all the relays, switches, rectifiers and other electrical equipment necessary to operate the motor and change shaft speed as the speed dial is adjusted.

The operator's controller is often mounted on a pendant near the machinery; or in a master console; or integrated into the control cabinet.

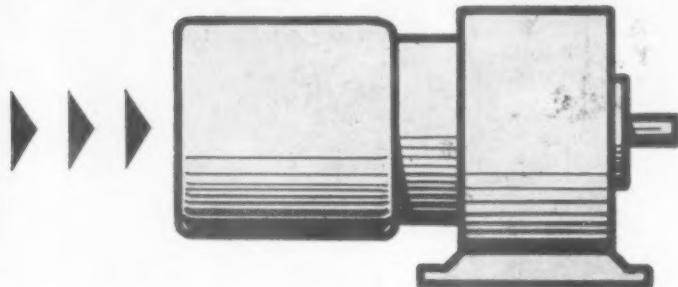
Because of the complexity of electrical drives, many manufacturers build their controls as "black boxes." They design them to keep inexperienced personnel from monkeying with the components. To offset this, since you can't service the equipment, reliability is guaranteed and design life is an important factor.

To permit your servicing, many manufacturers use modular and plug-in construction to permit maintenance personnel to pull out whole sections to check and replace, if needed. Other manufacturers keep field service personnel only minutes away to act as your service group. Others avoid short life components and build drives that have long, dependable life characteristics. Virtually all of them conduct schools in their or your plant.





.....gives you any speed you want



## precisely—electrically

**A-c or d-c, there's a drive for every purpose**

THERE ARE MANY TYPES of commercially-available drives. Most of them fall into a few categories such as rotary conversion from a-c to d-c, motor generator set is an example; static conversion from a-c to d-c, magnetic amplifier type is an example; a-c drives, wound-rotor motor type is an example; slip devices, eddy-current coupling type drive is an example; a-c/d-c drives, in which an a-c motor component is coupled with a d-c motor component on the same shaft; and others.

### D-C Adjustable Voltage Drive

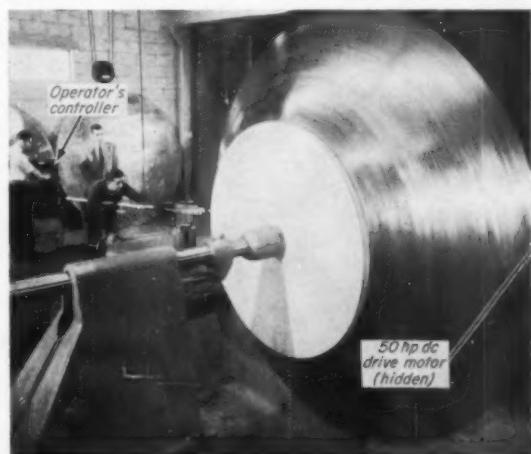
A packaged drive consists of a d-c drive motor, an operator's controller and a control that converts shop a-c into d-c. The packaged drive contains all its own conversion equipment; a non-packaged drive does not, may be spread throughout the plant.

Drives differ in method of conversion. The most common type is the motor-generator set, consisting of an a-c induction motor and a d-c generator. Drives are available from fractional to thousands of horsepower with constant-torque speed range of 8 to 1 or more. This type of drive provides a constant torque characteristic since speed is adjusted by manipulating generator field excitation and the applied d-c armature voltage to the motor. Greater constant torque speed ranges can be obtained by providing a circuit to "buck out" the generator residual voltage. If fre-

quent low speed operation for extended periods is required, forced cooling or de-rating of the d-c motor is usually required.

Speed adjustment in the constant horsepower range can be obtained by controlling the excitation of the

*Continued on next page*

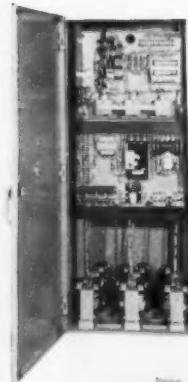


**ART OF METAL-SPINNING** is performed by man in foreground as man in background adjusts speed of spinning disc. Motor-generator type control provides wide speed range since work diameter constantly changes.

## THERE'S A DRIVE OF EVERY SIZE FOR EVERY PURPOSE . . .



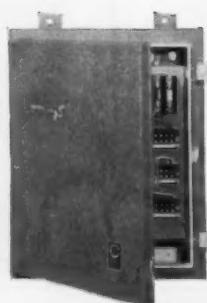
OPERATOR'S CONTROL STATION FOR  
LARGE ROLLING MILL DRIVE



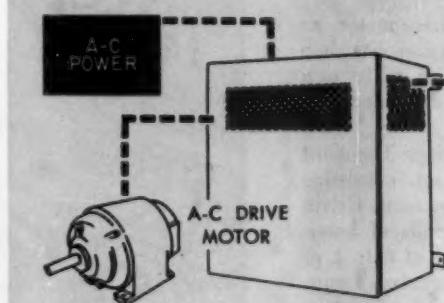
PACKAGED  
DRIVE



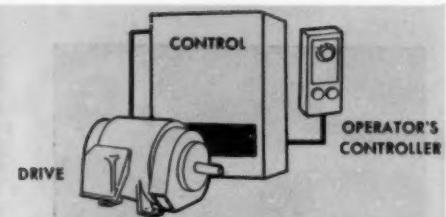
COMPLETE FRACTIONAL HP DRIVE



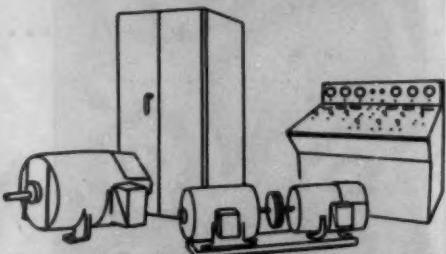
CONTROL CABINET  
LOCATED ANYWHERE



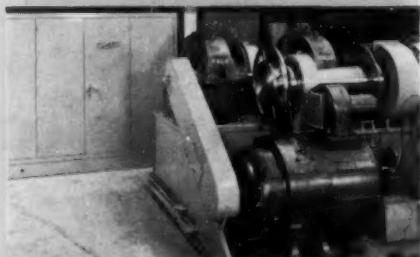
ALL A-C DRIVE



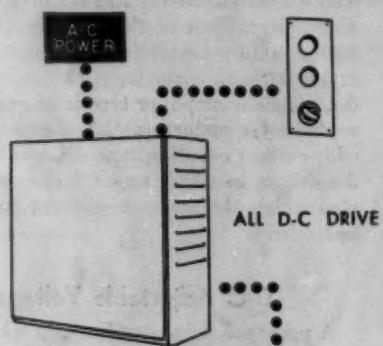
ELECTRICAL ADJUSTABLE SPEED DRIVE  
CONSISTS OF THREE BASIC ELEMENTS



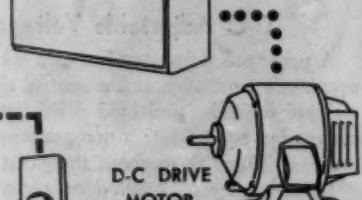
NON-PACKAGED DRIVE IS NOT  
SELF CONTAINED



CONTROL CABINET NEAR MACHINERY,  
OPERATOR'S CONTROLLER ELSEWHERE



ALL D-C DRIVE



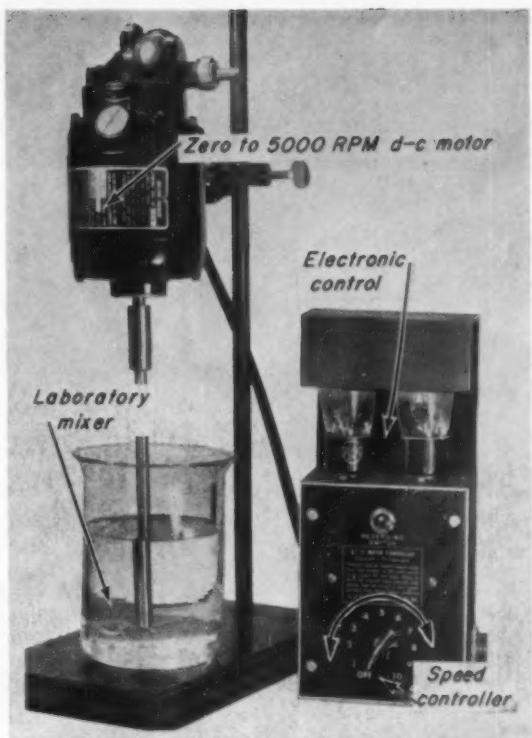
D-C DRIVE  
MOTOR

d-c motor field by means of a rheostat or regulator. First cost of this type drive is approximately 100% more (at 100 hp) than a standard eddy current coupling drive to approximately 15% more at 10 hp. Maintenance is low since only periodic bearing lubrication is required. Both the motor-generator set and the drive controls are located in the control cabinet in the package unit which is normally mounted near the driven machine. Operating costs are low since a relatively high efficiency is attained.

The adjustable voltage system is excellent for tandem operation since each motor may be supplied with a voltage proportional to line speed required. Relative motor speeds may be adjusted over an almost infinite range. Tandem drives can be made to track very closely as the machine speed is increased or decreased. The motor-generator type drive also has the ability to regenerate which is a recovery of power. This decreases power cost and provides a readily adjusted braking torque for high inertia or widely fluctuating loads. Regeneration also allows fast stopping and rapid reversing.

Other d-c drives utilize metallic rectifiers for power conversion. In this case, the armature voltage applied to the d-c motor is controlled by magnetic amplifiers utilizing self-saturating reactors. This type is available in ratings from  $\frac{1}{3}$  through 200 hp and is similar to the motor-generator type in characteristics and first cost. The only exception is that rectifiers can carry current in one direction only and therefore do not have the ability to regenerate. They should therefore not be used on overhauling-type loads or where a regenerative stop is required. The recently-

**CORRUGATED PAPER BOARD MACHINE** joins top and bottom paper members with rippled center member. Drive in background powers single-facer unit; drive in foreground powers double-backer unit. Each drive is in-



LABORATORY MIXER has fractional d-c gear-head motor, operates in either direction. Phase shift thyratron in closed cycle rectifier converts a-c to d-c. 18:1 gear reduction in motor head cuts shaft speed, lets motor operate in normal range.

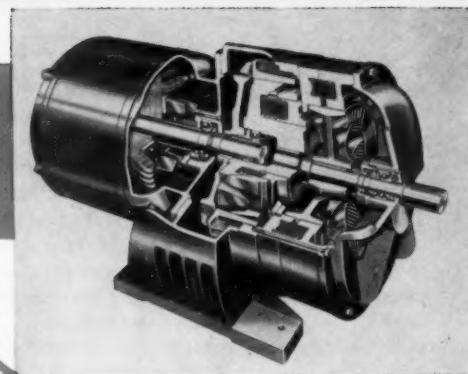
dependent of other but can be controlled from either panel. One in background is 60 hp, other 125 hp adjustable voltage, motor-generator type. Drives have good speed regulation.



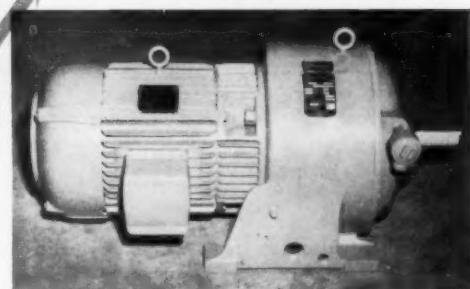
**THERE'S A DRIVE OF EVERY SIZE  
FOR EVERY PURPOSE . . .**



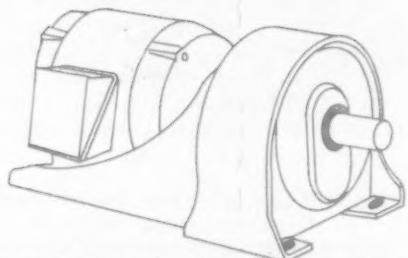
FRACTIONAL HP OPERATORS CONTROLLER



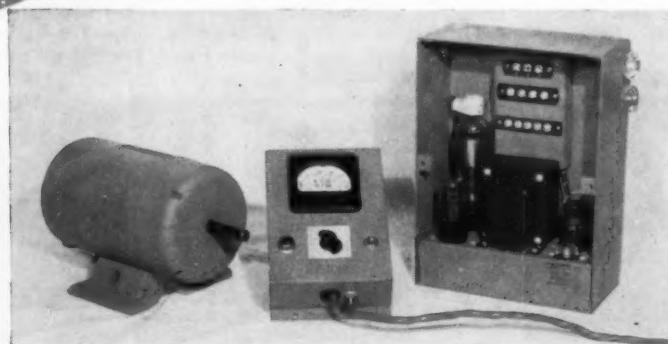
EDDY CURRENT COUPLING  
WITH EDDY CURRENT BRAKE



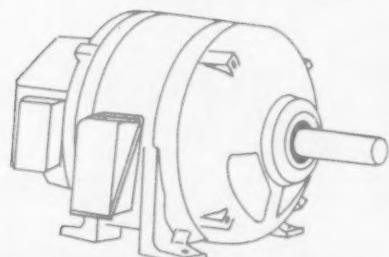
EDDY CURRENT COUPLING DRIVE MOTOR



ALL TYPES OF GEARMOTOR DRIVE MOTORS



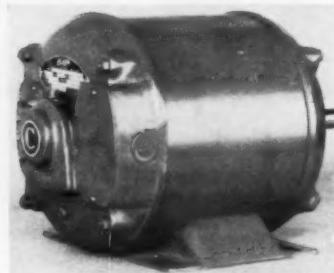
1/10 HP DRIVE WITH INDICATING TACHOMETER



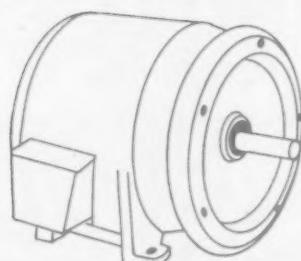
WOUND ROTOR A-C DRIVE MOTORS



FRACTIONAL HP DRIVE MOTOR  
AS SMALL AS YOUR JOB



HIGH HP DRIVE MOTORS  
FOR HEAVY DUTY WORK



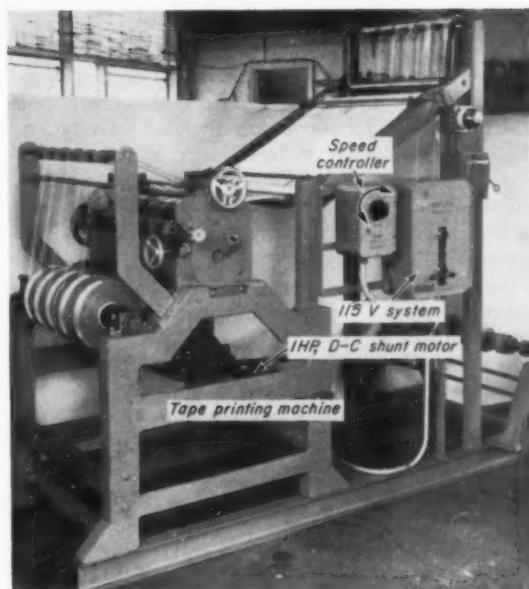
ALL TYPES OF FLANGED DRIVE MOTORS

developed silicon rectifier is also commonly used. They must be applied carefully, but long reliable life can be expected since no aging characteristics take place. Silicon rectifiers have increased the attractiveness of the rectifier conversion unit.

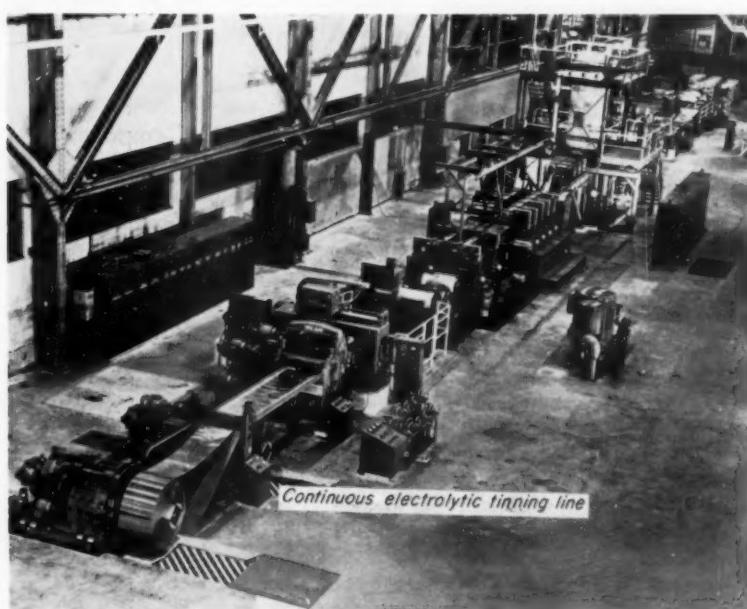
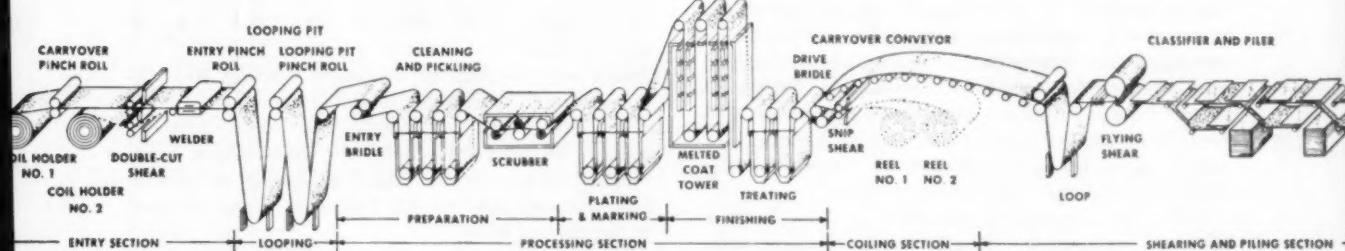
Other d-c drives utilize electronic tubes for power conversion. These drives are available in ratings up to approximately 100 hp but are most often used in ratings below 10 hp. They display the same general characteristics as metallic rectifier drives and are approximately equal in first cost. Normal maintenance consists of electronic tube replacement and lubrication of the drive motor bearings.

### Eddy Current Drive

The eddy current coupling is an electro-magnetic device used to obtain adjustable speed from a constant or variable speed source. The input shaft is driven by a prime mover, usually an induction motor and a controllable source of field excitation is provided. The output shaft is adjusted by controlling the excitation on the coupling field coil. Because of inherently drooping speed characteristic, a speed regulating circuit is used.



SPEED CONTROL of tape printing machine is provided by d-c drive that has extremely close speed regulation at any setting from zero to full speed. Error in feed speed would cause inaccurate printing register.



CONTINUOUS ELECTROLYTIC tinning line has multitude of drive motors and compensated speeds and controls. Speed is controlled as function of plating current so that tin deposit on metal stays constant. Drives are d-c and keep tension on metal steady.

Operation of an eddy current coupling is based on the principle that the current induced in a closed-conductor loop by a rotating field reacts with the field to produce torque in the direction of rotation. This torque can be produced only when there is relative motion or slip between the magnetic field and the conductor loop. The amount of slip depends on the output load torque and the strength of the magnetic field.

Since output torque is substantially the same at all operating speeds, the drive is commonly considered a constant torque drive.

Power at the output shaft is equal to the product of torque and output speed while the input power required is equal to the product of the input torque and input speed. The difference in power is absorbed by the coupling and appears as heat plus some friction and windage losses. These losses must be removed by cooling to permit continuous operation.

Since the power input to an eddy current coupling is almost constant, it follows that the drive becomes less efficient at low speeds as slip (and thus losses) is increased. For this reason, the cooling system capacity usually determines the continuous speed range of the coupling.

Standard eddy current coupling drives are also controlled from an operator's controller which includes pushbuttons and a speed setting dial. Drives are available in ratings from approximately 1 through several thousand horsepower. The standard available speed ranges for air-cooled couplings are approximately 17 to 1 in the low horsepower ratings and 1½ to 1 in the higher horsepower ratings. Speed ranges can be increased by providing more efficient cooling of the coupling and/or de-rating the drive.

Since the coupling is controlled by signals of a very low power level, it adapts readily to a wide range of modifications. Speed regulation is approximately 2%, but higher accuracies can be provided if required. The first cost of this drive is approximately 40 to 60% more than for an equivalent mechanical drive, but the coupling provides a wider speed and tension range.

Tubes are used in the standard exciter-regulator but magnetic amplifier regulators are also available. It is a fairly simple drive and usually requires less space at the load than an equivalent mechanical drive. This is because the control, which includes the excitation supply for the coupling field coil and the a-c motor control, is normally mounted remotely from the driven machine.

This type drive consists of a standard a-c induction motor mounted integrally with an eddy current coupling. The clutch drum (input member) runs at constant (a-c motor) speed while the speed on the clutch spider (output member) is adjustable.

Direct current from the control flowing in the stationary field coil generates a magnetic flux making the fingers on the clutch spider alternate north and south poles.

The relative motion between the clutch drum and the clutch spider causes any small section of the clutch

drum to pass alternately over the poles with the flux alternately changing direction. The resulting eddy currents in the drum create an electro-magnetic force which is the means of transmission of torque from the clutch drum to the clutch spider.

The amount of torque transmitted is proportional to the d-c excitation furnished to the stationary field coil. The tachometer generator continually monitors the output speed comparing it to a reference in the controller. By constantly modulating the amount of d-c excitation, the controller maintains the output shaft at the selected speed, independent of the load.

### Drive with Wound-Rotor A-C Motor

This type of drive consists of an induction drive motor, an operator's controller and a control. The drive is capable of adjusting motor torque smoothly to meet demands of the operator and of load driven by the motor.

The control contains a motor-starter, a set of thyatrons operating as an impedance control, and a closed-loop regulating system designed to link motor output to the desired process function, such as speed, tension, position, pressure, flow or other variable.

When the motor primary is energized, the speed reference setting exceeds feedback voltage to produce an error voltage. Error voltage increase causes an excitation increase. This current produces a field which reacts with the field of the motor primary and produces torque, causing the motor to accelerate.

As motor speed approaches the speed reference setting, the regulator reduces the tube current, hence motor torque, and the motor no longer accelerates but produces only enough torque to drive the load at the desired speed.

Since the secondary voltage and frequency of the motor vary directly as the slip, the thyatron tubes must operate over wide ranges of voltage and frequency.

### Drive With A-C and D-C Components

In a wound-rotor motor drive the secondary output of the motor is absorbed in resistors and dissipated. In an a-c with d-c component drive, the a-c output is rectified and used to power a d-c component. The drive cannot run away since the maximum speed is the synchronous speed of the a-c component, similar to an ordinary induction motor.

A-c secondary voltage increases as speed of the shaft decreases so that energization of the d-c component is increased as speed of the shaft decreases. Speed of the drive is controlled by changing the field excitation of the d-c component using a rheostat. The drive is suitable for either constant hp or constant torque applications.

When field current is applied to the d-c component, a counter emf is generated in the armature of the d-c component that opposes the rectified a-c output of the rotor over the speed range. The difference be-

tween these voltages is such that the rectified rotor voltage of the a-c component is sufficient to circulate load current through the rotor. When the d-c component field is weakened, the generated counter emf decreases, allowing more current to circulate. This produces more torque and the drive accelerates. As the speed increases, rotor slip voltage of the a-c component decreases and the counter emf increases. When the voltages differ by the amount required to circulate the load current at the new speed, the drive ceases to accelerate and stabilizes at that speed. When the field is increased, the above process operates in the opposite manner.

The drive consists of starter, a-c component, d-c component, slip rectifier for rectifying the a-c secondary voltage, and a field power supply including the field rheostat for speed control. The starter includes the necessary contactors, relays and secondary resistors to start the drive. The value of the secondary resistance is selected to suit the load acceleration requirement.

### Operation of D-C Drive Motors

D-c shunt-wound motors are normally used on all d-c drives.

Shunt field control is a method where voltage applied to the shunt field is varied. This is usually done by using a rheostat in series with the shunt field. As the shunt field voltage and current are lowered the magnetic flux is reduced and the speed goes up. Speeds below base speed cannot be obtained because the field would overheat with more than rated current and because magnetic saturation limits the flux.

Since the torque of a motor is proportional to the product of the flux and the armature current  
 $T = K\phi I_a$  ..... (1)

where

$T$  = torque, lb-ft

$K$  = constant

$\phi$  = magnetic flux in air gap

$I_a$  = armature current

torque at rated armature current decreases as flux is decreased to obtain higher speeds. Horsepower is proportional to the product of torque and speed

$$T \times RPM$$

$$HP = \frac{5252}{5252} \quad (2)$$

where

$T$  = torque, lb-ft

HP = horsepower

RPM = speed

Power at rated current is almost constant as the field is varied because the decrease in torque is offset by the increase in speed. Hence, an adjustable speed motor using field control has a constant horsepower capacity over its speed range.

Armature voltage control is where the shunt field excitation is maintained constant and the voltage on the armature is varied by controlling the output of a d-c generator or rectifier. This system is used in the motor-generator type control. The generator powers the motor which goes up and down in speed at the same time. Any speed from zero to rated speed can be obtained as the armature voltage is varied from zero to rated voltage.

*Continued on page 29*

### Electrical adjustable speed drive manufacturers\*

Allen-Bradley Company  
 Allis Chalmers Manufacturing Co.  
 Louis Allis Co.  
 Barber-Colman Co.  
 Bodine Electric Co.  
 Brook Motor Corp.  
 Brown-Boveri Corp.  
 Brown-Brockmeyer Co., Inc.  
 Carter Controls, Inc.  
 Century Electric Co.  
 Charles Bruning Co., Inc.  
 The Clark Controller Co.  
 Cleveland Machine Controls  
 Cramer Controls Corp.  
 Cutler-Hammer Co.  
 Diehl Manufacturing Co.  
 Eaton Manufacturing Co.  
 Electra Motors  
 Electric Products Co.  
 Emerson Electric Mfg. Co.  
 Euclid Electric & Mfg. Co.

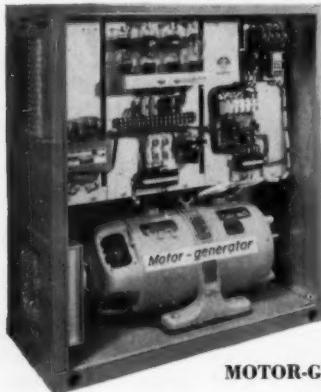
Euclid Universal Machine, Inc.  
 Fairbanks, Morse & Co.  
 Franklin Electric Co.  
 General Dynamics Corp.  
 General Electric Co.  
 General Industries Co.  
 Globe Industries, Inc.  
 Gerald K. Heller Co.  
 Hertner Electric Co.  
 Hoover Electric Co.  
 Howard Industries, Inc.  
 Howell Electric Motors Co.  
 Imperial Electric Co.  
 Jack & Heintz, Inc.  
 Janette Electric Mfg. Co.  
 The Leland Electric Co.  
 Lima Electric Motor Co., Inc.  
 Link Aviation, Inc.  
 Magnetic Amplifiers, Inc.  
 Magtrol, Inc.

Oxy-Dry Sprayer Corp.  
 Peerless Electric Co.  
 Rae Motor Corp.  
 Reliance Electric & Engineering Co.  
 Reuland Electric Co.  
 Robbins & Myers, Inc.  
 Servospeed Div.,  
 Electro Devices Inc.  
 Servo-Tek Products Co., Inc.  
 Stratos Div., Fairchild Engine & Airplane Corp.  
 Square D Co.  
 Stearns Electric Corp.  
 Torq Engineered Product Co.  
 U. S. Electrical Motors  
 Vickers, Inc.  
 Ward Leonard Electric Co.  
 Weltronic Company  
 Westinghouse Electric Corp.

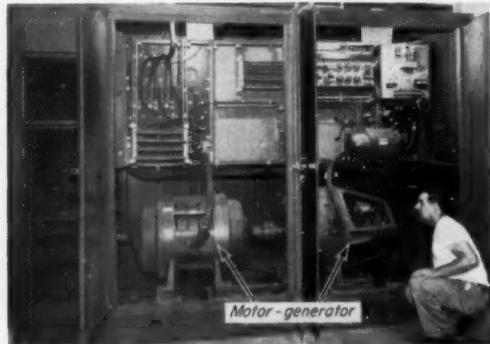
\*Companies that responded to our questionnaire

# Here are some important adjustable

## A-c to d-c rotary conversion



MOTOR-GENERATOR



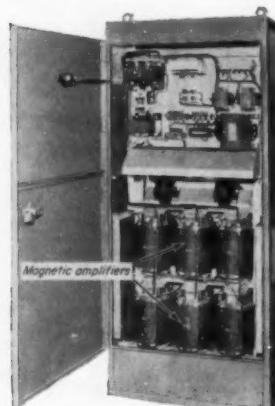
MOTOR-GENERATOR

**A-C CONVERSION** to d-c is accomplished with motor-generator set. Drive may be self-excited with series d-c generator and motor, or shunt d-c motor and generator; can be separately-

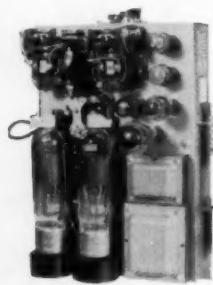
excited with rheostat in generator field. Field excitation can be supplied from rotating exciters, such as smaller d-c generator coupled to m-g motor shaft, or by rectifying part of a-c current.

Field excitation can also be achieved by using separate electronic or dry-plate rectifiers, rotary, electronic or magnetic amplifiers. More than one drive motor can be powered.

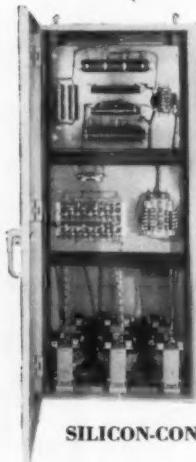
## A-c to d-c static conversion



MAGNETIC AMPLIFIER



ALL ELECTRONIC



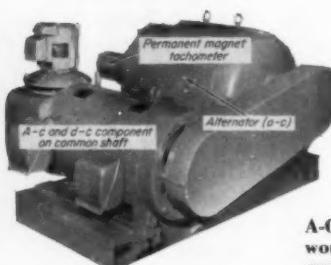
SILICON-CONTROLLED RECTIFIER

**A-C CONVERSION** to d-c is accomplished electronically, with magnetic amplifiers, solid state components with tap-changing transformers, bridge rectifier induction regulators, adjustable transformers, silicon rectifiers and saturable reactors. Principal electronic component is often thyratron tube in half or full wave circuit. Excitron and ignitron tubes are also used.

## A-c drives



ALL A-C ADJUSTABLE SPEED DRIVE.

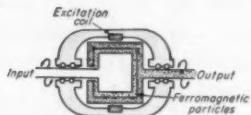


VARIABLE FREQUENCY,  
400 CPS maximum.

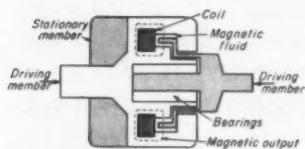
**A-C DRIVES** usually adjust speed of wound-rotor a-c motor. Variable frequency drive changes driving frequency of a-c motor, changing speed.

# speed drive differences

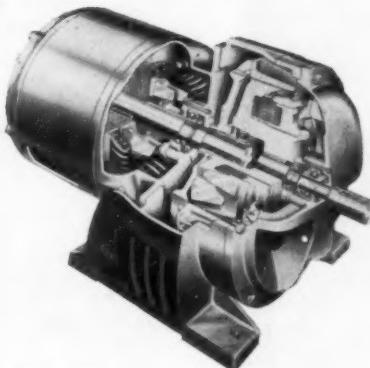
## Electro-mechanical slip devices



MAGNETIC PARTICLE CLUTCH



MAGNETIC FLUID CLUTCH



EDDY CURRENT COUPLING

ELECTRO-MECHANICAL SLIP devices provide speed adjustment by mechanically slipping. Chief of these are magnetic particle clutch, magnetic fluid clutch, eddy-current coupling, salient-pole magnetic coupling and hysteresis clutch. Eddy-current type drives are widely used throughout industry.

## How to adjust d-c motor speed

D-C SERIES MOTORS can be adjusted by adjusting line series resistance, armature shunt resistance or series and armature shunt resistance.

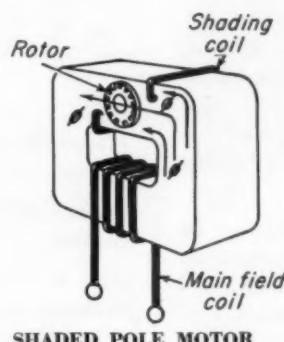
PERMANENT-MAGNET MOTORS can be adjusted by adjusting line voltage and series resistance. COMPOUND MOTORS can be adjusted by adjusting

line voltage, series resistance and shunt field resistance.

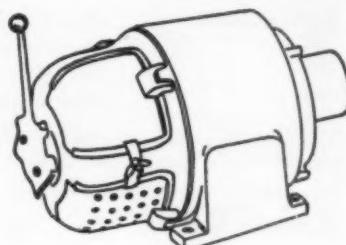
## How to adjust a-c motor speed

SERIES MOTORS ON A-C can be adjusted by varying voltage across field and armature with resistors, or with auto-transformers, tapped transformers, centrifugal governors and by shifting brushes. SHUNT MOTORS ON A-C can be adjusted by providing resonant circuit in shunt field for near unity power factor. REPULSION MOTORS ON A-C can be adjusted with series resistors that increase slip, with reactors in power circuit, with adjustable transformers, or with brush shifters. IMPULSE MOTORS can be adjusted with a special thumb nut control. SHADED POLE MOTORS can be adjusted by adjusting main field current, shading coil current, or by varying input power with tapped or adjustable auto-transformers, tapped or adjustable resistors, tapped or adjustable inductors, tapped main field coils, or tapped shaded coil.

SPLIT-PHASE MOTORS can be adjusted by changing winding connections to change number of poles.



SHADED POLE MOTOR



BRUSH SHIFTING MOTOR

CAPACITOR MOTORS can be adjusted (permanent split-type only) by reconnecting split field windings or using auto-transformer.

POLYPHASE SQUIRREL-CAGE MOTORS can be adjusted by reducing input voltage with rheostats, using inductive reactors in series with the input leads, by reconnecting windings, or using magnetic controllers.

WOUND-ROTOR MOTORS can be adjusted by changing (primary) voltage, or inserting resistance in rotor (secondary) circuit.

SYNCHRONOUS MOTORS can be adjusted by reconnecting windings.

SCHRAGE MOTORS can be adjusted by shifting brushes.

## Other types of drives

SPECIAL DRIVES include constant potential drives powered from plant d-e

bus with field weakening and armature shifting units (generally obsolete); d-c

field weakening motor and a-c slip ring motor mounted on common shaft.

# Glossary of descriptive terms

Adjustable-speed drive	<i>A drive designed to provide intentional and operable speed adjustment within specified range</i>	which is greater than warranted by desired controlled speed, in order to bring about a greater rate of speed change
Adjustable-voltage control	<i>Form of armature-voltage control obtained by impressing voltage on armature of motor in small increments; but once adjusted, voltage and speed of motor are practically unaffected by the change in load. Voltage may be obtained from shunt-wound generator with adjustable field current for each motor</i>	Speed which output shaft attains with rated load connected and with drive adjusted to deliver rated output at rated speed
Armature-voltage control	<i>Method of controlling speed by magnitude of voltage impressed on motor armature winding.</i>	Provision in control system by which voltage drop (and corresponding speed drop) due to armature current and armature circuit resistance is partially or completely neutralized
Braking	<i>Control function of retardation by dissipating kinetic energy of drive motor and driven machinery</i>	Quickly repeated closure of circuit to start motor from rest for purpose of accomplishing small movements of driven machine
Current-limit control	<i>System of control in which acceleration, retardation, or both, are governed so that armature current during speed changes does not exceed predetermined value</i>	Mechanical braking System of braking in which kinetic energy of drive motor and driven machinery is dissipated by friction of mechanical brake
Dynamic braking	<i>System of braking in which motor is used as generator, and kinetic energy of motor and machinery is dissipated as heat in resistors</i>	Minimum speed Lowest speed within operating speed range
Electric drive	<i>A system of one or several motors and a control that governs motor performance</i>	Motor-field control Method of controlling speed change in magnitude of field current
Electronic control	<i>Major portion or all basic functions are performed by electron tubes</i>	No-load speed Speed which output shaft of drive attains with no external load connected and with drive adjusted to deliver rated output at rated speed
Electronic rectifier	<i>Electron tubes are used as rectifying elements</i>	Operating speed range Range between lowest and highest rated speeds at which the drive may perform at full load
Forcing	<i>Application of control impulses to initiate speed adjustment, magnitude of</i>	Plugging System of braking in which motor connections are reversed, so that motor develops countertorque thus exerting retarding force

## D-C DRIVE MOTORS continued from page 25

The speed of the motor is approximately proportional to the voltage applied to its armature circuit. Speeds above rated speed can be obtained by this method only if the motor and generator is capable of withstanding more than rated voltage.

Since excitation is constant, flux is constant and therefore torque at rated armature current is constant. Motors operated on this system are a constant torque capacity over their speed range. The horsepower at rated current, however, increases from zero up to rated HP as the armature voltage and speed are varied from zero to their rated values.

Combination of armature voltage control and shunt field control, gives very wide speed ranges. Armature voltage control is used for speeds below base speed and shunt field control is used to obtain speeds above this.

Armature resistance control uses various values of resistance in series with the armature. The motor is operated from a constant-voltage source. This is a variation of armature voltage control since the voltage at the motor terminals is reduced by the amount of the voltage drop across the resistance.

This method is commonly used in starting d-c motors, but is unsatisfactory otherwise (except on small machines) for two reasons. First, there is a considerable power loss in the resistance, reducing the efficiency of the system. And second, the speed regulation changes for every change in resistance and becomes very poor at low speed. ▲▲▲

### Regenerative braking

**Form of dynamic braking in which kinetic energy of motor and driven machinery is returned to power supply system**

### Rheostatic braking (resistance braking)

**Form of dynamic braking in which kinetic energy of motor and driven machinery is dissipated in resistors**

### Speed adjustment

**Speed change of a motor accomplished intentionally through action of control**

### Speed variation

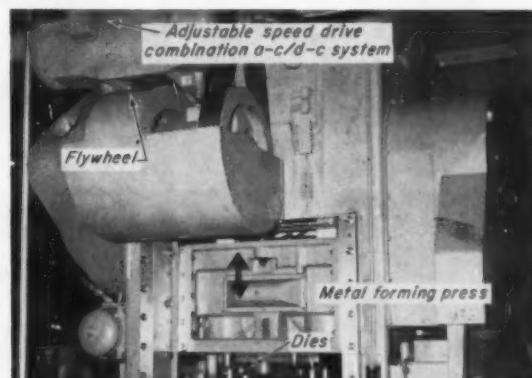
**Any change in motor speed independent of control system adjustment, such as line-voltage change, temperature, or load change**

### Variable-speed drive

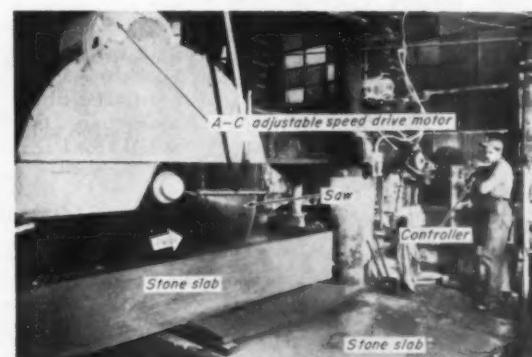
**Synonomous with adjustable speed drive**



**WIDE SPEED RANGE** is required during impressing of rubber backing on cloth sheets. Drive is electronic-type, converts a-c to d-c. Speed control is achieved through adjustment of motor voltage.



**METAL FORMING PRESS** has wide speed range to adjust to different production schedules. Drive is part a-c, part d-c. Wound-rotor a-c component is on common shaft with shunt wound d-c component which gives unusual speed control advantages.



**STONE CUTTING** with adjustable speed saw blade is accomplished with all a-c system. No d-c conversion is accomplished. Drive motor is wound-rotor whose speed is controlled by operator, has full speed range and provides speed regulation of 3%.

**A Model For Every Job**

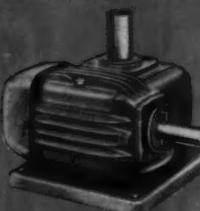


P-Series (No Base)



P-Series (High Base)

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LINE**



P-Series (Low Base)



S-Series

**A Complete Line Of Fin And Fan Cooled Speed Reducers**



U-Series



U-Series  
(with "C" flange)



U-Series  
(with "T" flange and coupling)

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**...WITH A MODEL FOR EVERY JOB**

Only a representative group of the more than 100 Hi-Line models are shown here. There

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**OHIO GEAR Company**

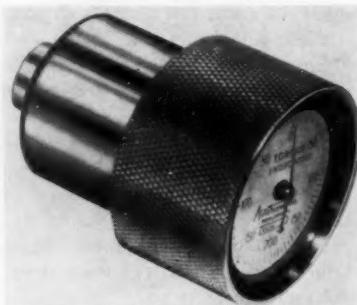
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For more information circle No. 29 on Reader Service Card

CONTINUED from page 16

**Torque indicator**

Direct reading, hand-size unit in 4 basic ranges: 1 to 15, 2 to 50, 2 to



150 and 2 to 200 oz-in. Two percent accuracy is attained.

*Autotronics Inc., Florissant, Mo.*

Circle number 205 on reader service card

**New brake line**

Series 42,000 offers torque ratings of 125, 175, 230 ft-lbs with extension up to 575 ft-lbs in near future. Can be mounted on motor frames 324UC through 405UC. Either ac or dc,



standard or waterproof enclosures. Entire mechanism is attached to single plate for easy assembly and disassembly. Shaft may be extended completely through the brake.

*Stearns Electric Corp., Milwaukee, Wisc.*

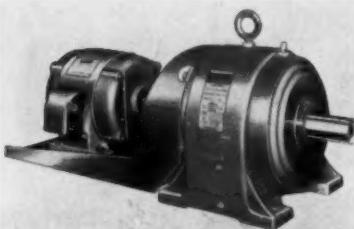
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for more information on any new product items on these pages, use Reader Service Card opposite page 64. Just circle number or numbers you want, fill out Card and drop it in the mail. We'll do the rest.

## Gear reducers

Universal NEMA motor mounting facility permits easy use of suitable motors with company's line of horizontal, foot-mounted-reducers. Shaft



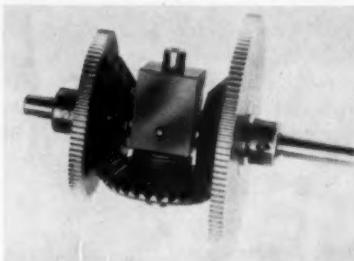
alignment is not affected by mounting stresses and high overhung loads are possible. Reducers are double (1 to 125 hp, reductions from 230 to 45 rpm) and triple (1 to 50 hp, reductions from 37 to 7-1/2 rpm).

*Lima Electric Motor Co., Inc., Lima, Ohio.*

Circle number 207 on reader service card

## Miniature differential

Precision three-gear differential for electronic computers has backlash of only 8 min of arc and breakaway torque of .3 oz-in. Maximum recom-



mended load at 2500 rpm is 75 oz-in. Unit features 6 precision bearings, is available with shaft lengths to 4 in.

*Dynamic Gear Co., Amityville, N. Y.*

Circle number 208 on reader service card

## AC motors

New line integral-hp motors, named Duty-Master. 1 to 250 hp in protected, weatherproof, totally-enclosed, corrosion-proof and explosion-proof enclosures. Designs include polyphase, ball bearing, vertical and horizontal mounting arrangements. Low-inertia, fast-accelerating rotor gives more protection.

*Reliance Electric and Engineering Co., Cleveland, Ohio.*

Circle number 209 on reader service card

Continued on next page

## Here's the Easiest... FLEXIBLE COUPLING

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Acme Flexible Couplings are quickly assembled or dis-assembled by means of a chain that has only one pin to connect or remove. Connecting links are permanently positioned on chain to engage connecting pin without difficulty in assembly. Positive Power Transmission is assured, with provisions for both angular and parallel misalignment. They absorb shock loads, provide maximum flexibility with minimum backlash. All steel construction to give maximum life expectancy. You save money in the long run.

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Special Catalog CPI-57  
on Flexible Couplings.

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CONTINUED from preceding page

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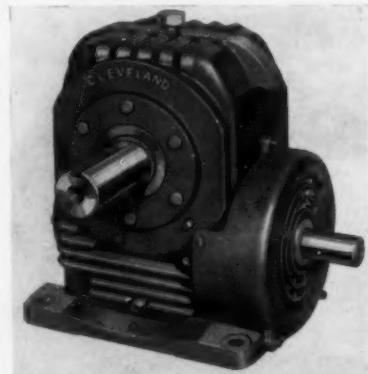
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### Speed reducers

"High horsepower" reducers, 1 to 40 hp, transmit up to 80 percent more hp than conventional worm gear units. Use of fan cooling, centrifugally cast



bronze gears and special heat treating techniques on alloy steel worms give substantially higher input hp and output torque ratings with smaller units.

*Cleveland Worm & Gear Co., Cleveland, Ohio.*

Circle number 210 on reader service card

### Rated motors

Driproof electric motors in new NEMA rated frame sizes 182 through 445 URS, from  $\frac{1}{2}$  hp at 3600 rpm through 150 hp at 900 rpm. Aluminum rotors are equipped with



dual cooling fans and entire rotor assembly is dynamically balanced. Either 2 or 3 phase in all frequencies and voltages below 600 v.

*Lima Electric Motor Co., Inc., Lima, Ohio.*

Circle number 211 on reader service card

### Variable-speed drive

Mechanical drive has separate motor construction and horizontal assembly.

*Continued on page 34*

# Now U.S. hones gears to superfinish

for:  
**SMOOTHNESS**  
**QUIET RUNNING**  
**LONGER LIFE**

HOBING gears is like  
SAWING WOOD. All  
gears are hobbed.

SHAVING gears is  
like PLANING. Some  
makers shave gears.

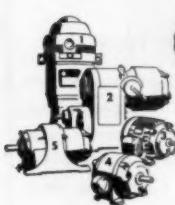
ONLY U.S. goes a step  
farther and HONES gears!  
That's like sanding for  
extra smoothness!

*another reason to specify:*

## **U.S. Syncogear Motors**

Among the makers of electric gearmotors, only one — U.S. Motors — *hones* gears to assure extremely accurate profile and smoothness. This honing means quiet running and longer life. Gear hobbing, the necessary first step in cutting gear teeth, leaves a degree of roughness analogous to sawing wood. Many gear makers go no further. Some, however, shave the gear teeth before hardening. This leaves a surface analogous to planing wood.

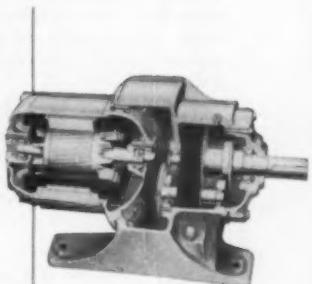
The ultimate refinement in tooth profiling, however, is honing — which may be likened to sanding of wood. This takes place *after* gear teeth are hardened. Thus, it takes out any imperfections and minor heat-treat distortions. It is to assure precision and exclusive refinements such as this that U.S. makes its own gears. Another good reason to specify: "U. S. SYNCROGEAR MOTORS." (½ to 50 H.P.)



**U.S. ELECTRICAL MOTORS INC.**

**U.S. MAJOR MOTOR LINES INCLUDE:**  
1. Vertical Solid & Hollowshaft, 2. Varidrive, 3. Totally-Enclosed,  
4. Uniclosed, 5. Syncogear. Also, many other special motors.

P. O. BOX 2056  
LOS ANGELES 54, CALIFORNIA  
OR MILFORD, CONNECTICUT



SEND FOR FREE  
SYNCROGEAR MOTOR  
BROCHURE NO. F-1880,  
explaining the  
Syncogear principle.  
Color illustrated.

For more information circle No. 39 on Reader Service Card



**Eliminate "high-cost specials"  
by standardizing on**

## **AMERICAN STOCK GEARS**

Investigate and you'll probably find that instead of having to go to the added time and expense of ordering special gears, that your needs can be filled from the American line.

American is a 'complete' stock gear line. Manufactured by Perfection — a veteran of over 30 years in the gear business — these gears are made to the most precise standards, from the highest quality materials. This popular line includes brass, bronze, steel, semi-steel, cast iron, and non-metallic gears in a range of 48 to 3 diametral pitch.

You'll save time and money . . . save on inventory . . . simplify purchasing and have less lost production time by procuring your stock gear needs from your nearby distributor of American Stock Gears.



Ask for FREE copy of American Stock Gear Catalog No. 360 containing detailed information and engineering data.

### **AMERICAN STOCK GEAR division**

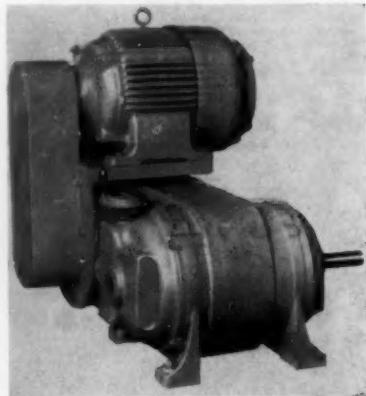
Perfection Gear Co., Harvey, Illinois



For more information circle No. 31 on Reader Service Card

**CONTINUED from page 32**

Wide selection of infinitely variable output speed ranges with proper V-belt and timing belt use.  $\frac{1}{2}$  to 30 hp.



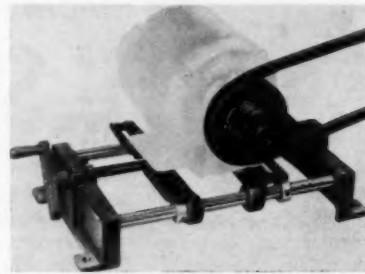
output speeds from 4660 to 1.2 rpm, speed variations from 2 to 1 to 10 to 1. Drip-proof, totally-enclosed, explosion-proof styles.

*Sterling Electric Motors, Los Angeles, Calif.*

**Circle number 212 on reader service card**

### **Spring loaded pulleys**

Variable-pitch pulleys have spring-tensioned sliding flange that automatically adjusts to various pitch diameters and always holds belt firmly in place. Pulleys are mounted on motor or driver shaft and coupled by an



A or B belt with fixed diameter pulley to form the variable-speed drive.

*Maurey Mfg. Corp., Chicago, Ill.*

**Circle number 213 on reader service card**

### **FOR QUICK ACTION . . .**

for more information on any new product items on these pages, use Reader Service Card opposite page 64. Just circle number or numbers you want, fill out Card and drop it in the mail. We'll do the rest.

NOVEMBER 1959

DESIGN  
**IDEAS**  
FROM THE FIELD

## Electric clutches give push button control

TWO ELECTRIC CLUTCHES and an electric brake automate the operation of a gasoline engine that powers a material hoist. The clutches and brake are an integral part of the main hoist gear box. Power is supplied by the engine's 12-volt dc system.

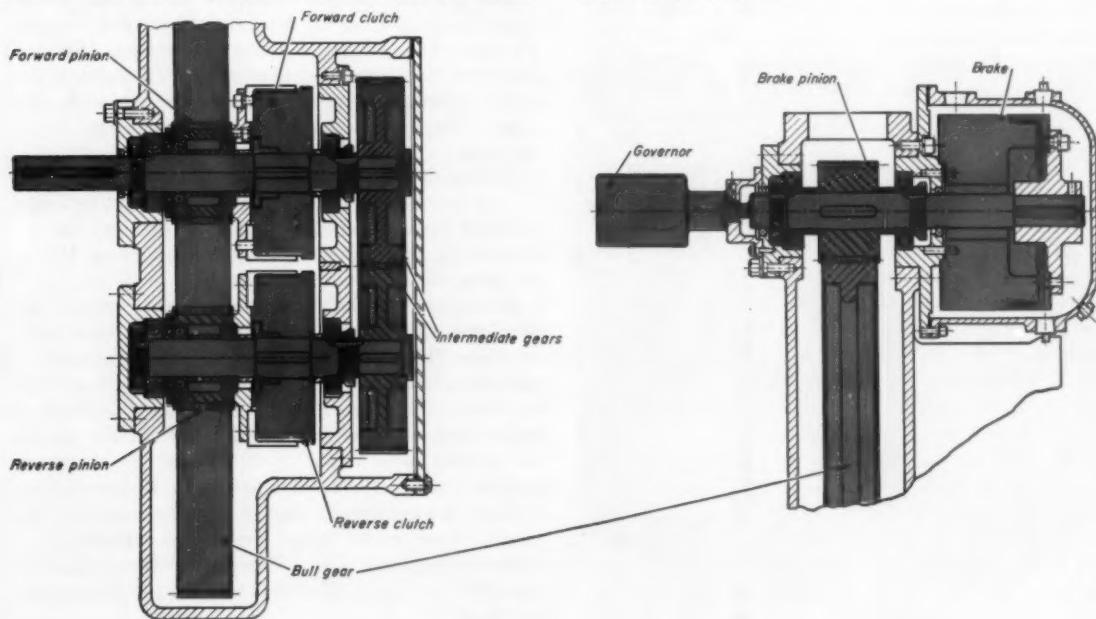
The 25-hp, air-cooled engine drives the gear box input shaft through multiple V-belts. Input shaft

drives one clutch and one of a pair of intermediate gears. A pinion gear concentric with the input shaft meshes with a bull gear. The driven member of the adjacent clutch is fastened to this pinion so it will be driven when the clutch is engaged.

*Continued on next page*

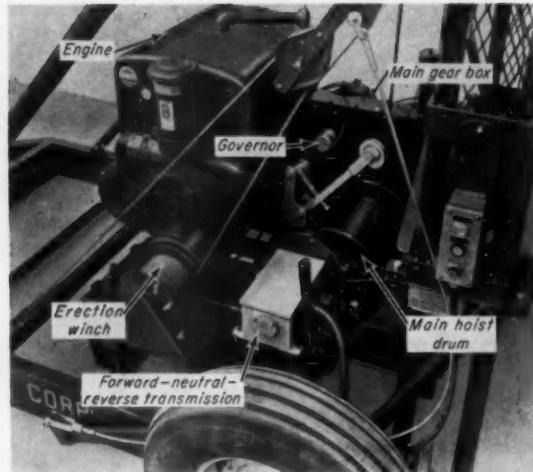
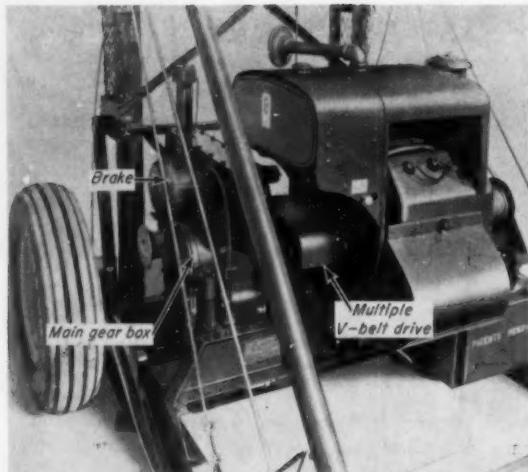
CROSS-SECTIONS through main gear box. Forward, reverse, and brake pinions are 3.5 PD, 28 tooth.

Bull gear is 24 PD, 192 teeth. Intermediate gears are 6.75 PD with 54 teeth.



## IDEAS

continued



MOBILE HOIST is gasoline-engine powered and electrically controlled.

### ELECTRIC CLUTCHES continued

The intermediate gear on the input shaft meshes with another intermediate gear to drive another shaft. On this second shaft are mounted another electric clutch and pinion. This pinion is mounted in the same way as the other and connected to the driven member of the adjacent clutch. It also meshes with the same bull gear. Forward or reverse rotation of the bull gear and connected hoisting drum is selected by engaging one or the other of the clutches.

A third pinion also meshes with the bull gear. This pinion is on another shaft which drives the rotating member of an electric brake. This brake is spring applied and electrically released so the hoisting drum will automatically be braked through the pinion and bull gear if the electrical power supply should fail. The brake shaft also drives a governor, or speed sensitive centrifugal switch.

The unit raises and lowers the platform of the hoist called the HoisTower by reeling in or unreeling a wire rope which runs over sheaves to the top of the tower and down to the platform. Control is by push-button. The clutch to give the desired motion is engaged by pushing an *up* or *down* pushbutton. The control system automatically disengages the brake

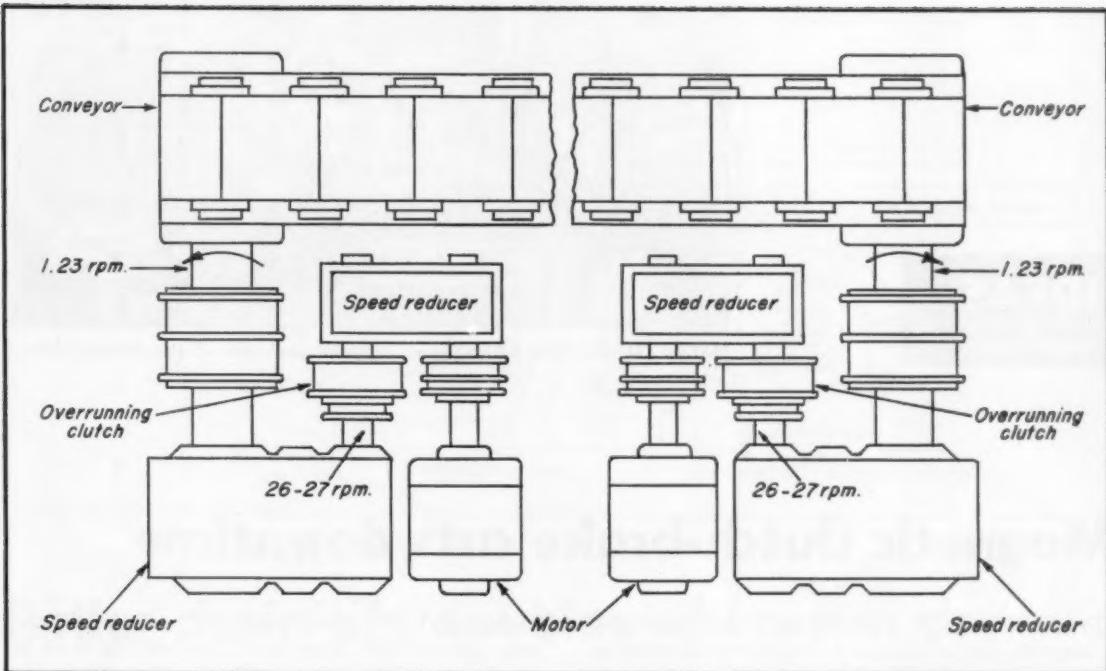
and operates a solenoid to open the throttle when a button is pushed.

The governor detects overspeed which may occur when lowering a heavily loaded platform and engages the *raise* clutch to slow the rate of lowering. Also, another set of contacts in the governor will open if the speed appreciably exceeds the speed at which the *up* clutch is engaged to disengage both clutches and apply the brake.

A rotary limit switch driven by the hoist drum shaft is used to establish and control upper and lower limits of hoist travel. Since the height of lift may be increased by the addition of tower sections to 150 ft or more, the limit switch is adjustable.

In addition to the hoist transmission, there is an auxiliary transmission used to make the tower self-erecting. This consists of a small forward-neutral-reverse gearbox driving a small winch through a shaft and universal joints. Through a linkage, this raises a folded tower section into place and folds the wheels so the unit rests firmly on the ground on its frame. Height of the self-erected tower is 45 ft. Erection or folding the unit to its towing position where it becomes its own trailer is just a matter of minutes.

Buck Equipment Corp., Cincinnati, Ohio, manufactures the HoisTower. Design is by Albert E. Kerr, chief engineer.



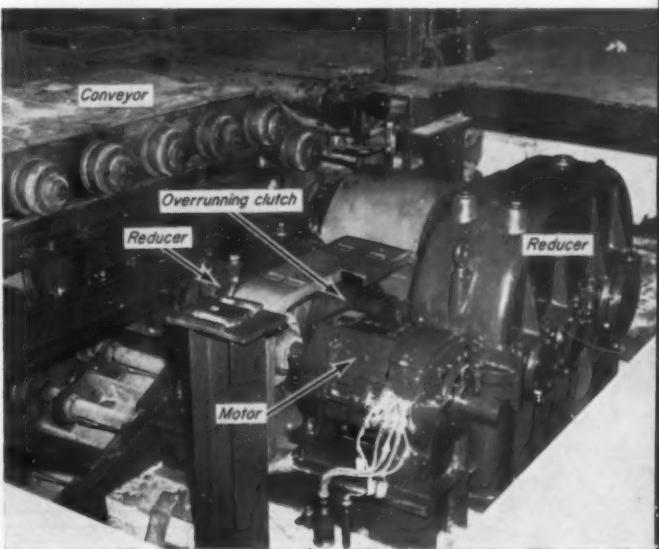
## Overrunning clutches remove non-working drive load

DUAL DRIVES, one at each end, are needed to permit drive reversal operation in both directions in a steel coil pallet conveyor at the world's largest 80-in. strip mill. To reduce the load on the operating motor, overrunning clutches are used to disconnect a portion of the non-working drive.

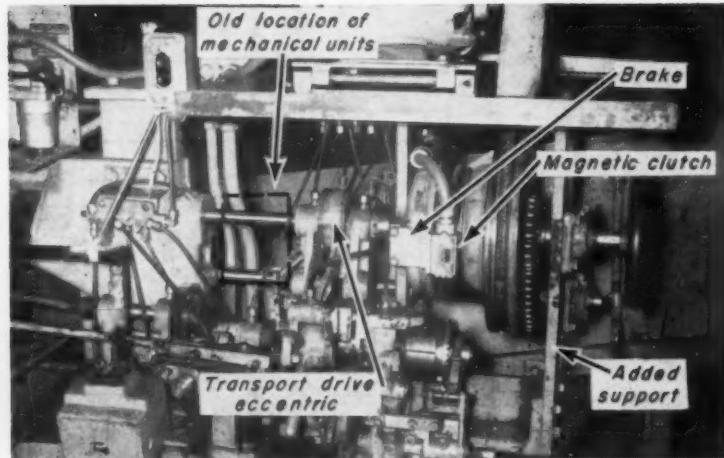
Identical drive units, with the exception of direction, are at each end to carry steel coils weighing as much as 15,000 lb to a station where they are picked up for deposit in an acid bath pickle. Each drive consists of a 25-hp motor which operates at 650-675 rpm; a double-reduction, herringbone gear reducer with ratio of 24.8:1; overrunning clutch, and another double-reduction, herringbone gear reducer with ratio of 21.21:1. This gives a conveyor sprocket drive speed of 1.23 rpm.

The overrunning clutches thus disconnect the load of one speed reducer and the electric motor from the other drive.

This installation is at U. S. Steel Corp.'s. sheet and tin mill at Gary, Ind.



**IDEAS**  
continued



MAGNETIC CLUTCH-BRAKE was mounted outboard of the existing drive.

## Magnetic clutch-brake cuts downtime

REPLACEMENT OF A mechanical clutch-brake with a magnetic clutch-brake on a container folder-stitcher eliminated considerable downtime. The new clutch-brake now starts and stops the transport and stitching units and prevents loss of synchronization. Variations were previously caused by change in coefficient of friction of the mechanical friction surfaces which caused delay for adjustment.

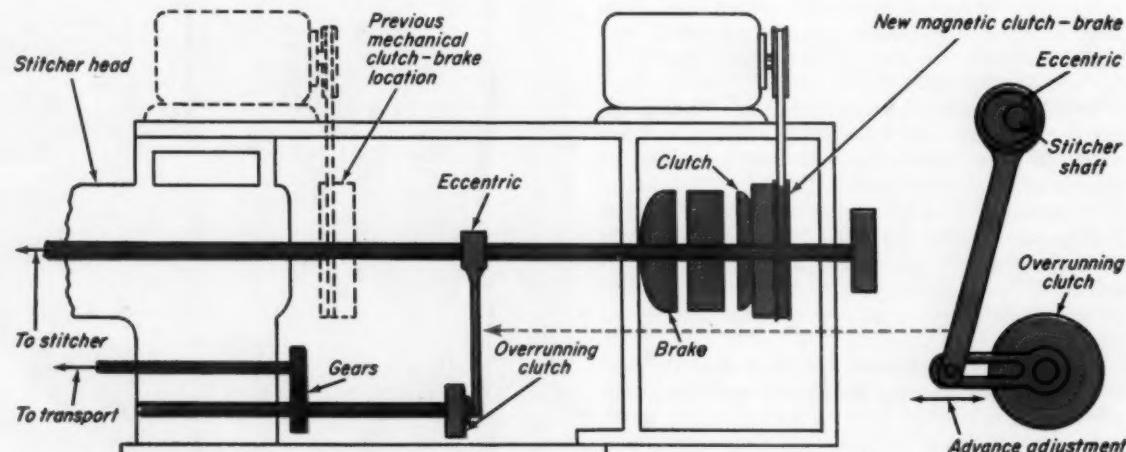
Maintenance costs have been halved by elimination of the time usually spent on adjustments to the mechanical units. By the same token, production of the machines increased by at least 50%.

Both the container transport and the stitcher head

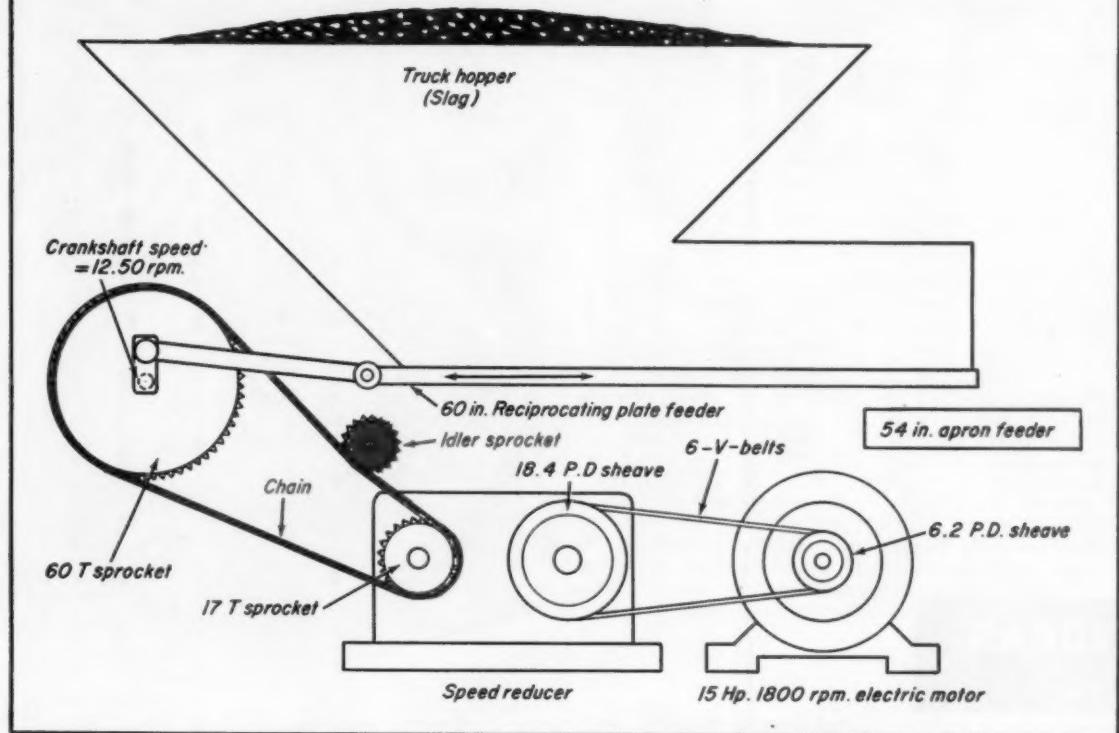
are driven by the same motor and controlled by the same clutch-brake. Rotation of the stitcher shaft is converted to intermittent unidirectional motion by an eccentric and an overrunning clutch.

Conversion from the mechanical to the magnetic clutch-brake required lengthening of the machine since the magnetic units would not fit in the same space. Mechanical units were simply removed and the shaft lengthened to take the magnetic units. A new, longer support frame was added for the drive motor. Power is transmitted from the motor to the clutch by V-belt.

This conversion was made at Cornell Paperboard Products Co., Milwaukee, Wisc.



CONVERTED DRIVE uses a magnetic clutch-brake to eliminate troubles from variations in coefficient of friction.



## Roller chain life doubles when run dry

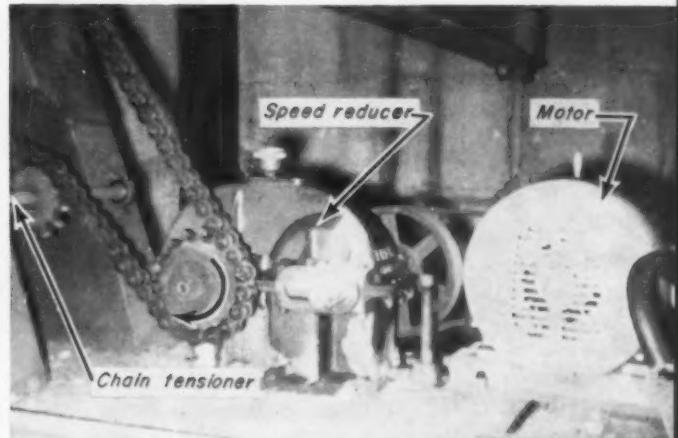
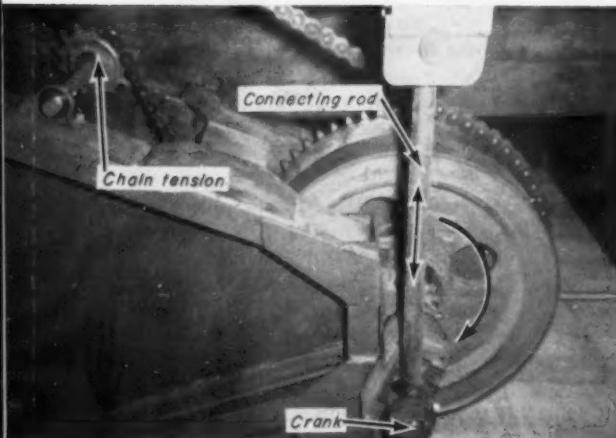
CHAIN LIFE in the presence of dust from blast furnace slag is doubled when the chain is run dry instead of with lubrication on a reciprocating feeder. With lubrication, the grease mixed with the dust to form a gummy paste.

Previously, the speed reducer shaft was continually breaking. Everything looked all right, but it was decided that the shock loading due to removal and reapplication of the load as the crank went through dead center was responsible. Addition of a tensioning idler sprocket, which was not thought necessary on first in-

stallation, solved the breakage problem.

Complete drive consists of: a 15-hp, 1800-rpm motor driving a 13.3:1 speed reducer through a multiple V-belt drive, with speed reducer output connected to the crankshaft through the roller chain drive, using 17- and 60-tooth sprockets to give 3.5:1 reduction. Final speed of the crankshaft with this set-up is 12.5 rpm. The crank mechanism is adjustable to give strokes from 2 to 10 in.

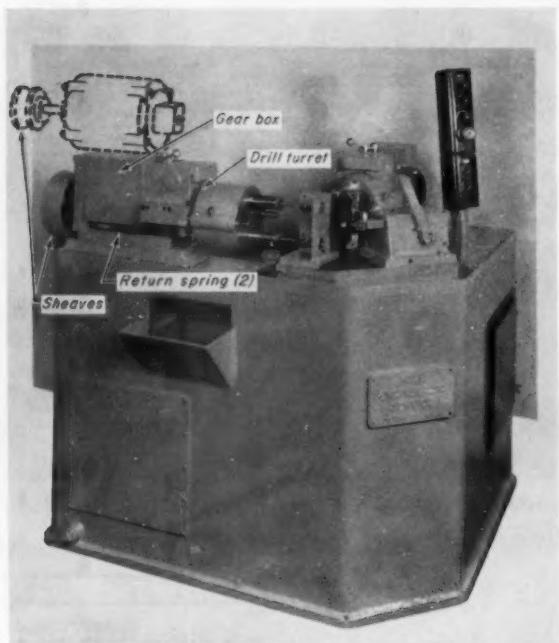
The drive is now in operation at a plant of *The Buffalo Slag Co., Inc.*, Buffalo, N. Y.



## IDEAS

continued

**DRILL TURRET** is advanced forward by direct gear drive; returned by springs.



## Return springs eliminate motor reversal

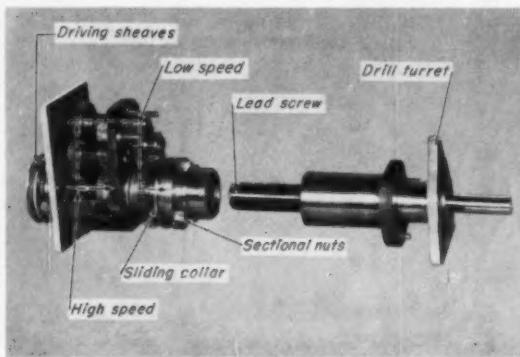
**DRILL AND SPINDLE** are rapidly returned by the energy stored in a pair of springs in a new drill unit. This eliminates the need for motor reversal, gear shifting, and all other modifications to the power transmission system to permit reversal.

Rapid advance and controlled drilling in the feed direction are obtained by gear shifting. Solenoids are used for gear shifting as well as engagement and disengagement of the lead screw which gives controlled feed.

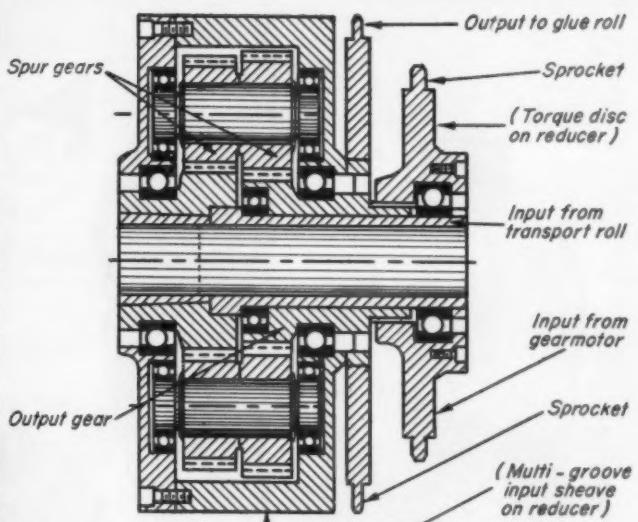
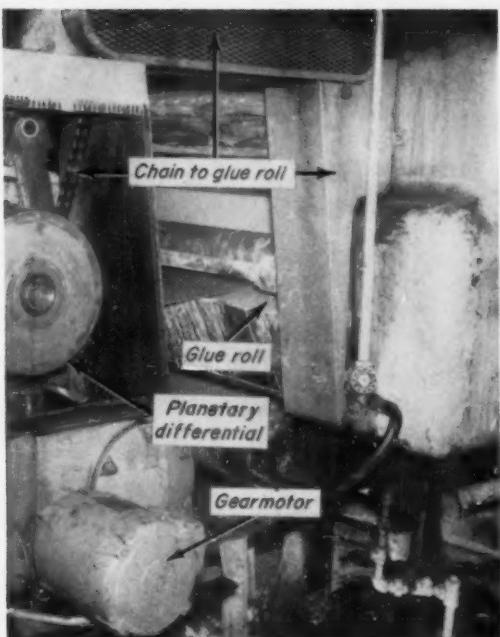
Motor mounted atop the unit case may be connected to the drill unit input shaft by V-belt or gearing. The input shaft drives both the tool spindle and a gear on the surface of a sleeve coaxial with the input shaft. This gear drives a countershaft through a meshing gear. A sliding gear on the countershaft can be shifted to drive directly to a sleeve carrying sectional nuts which feed the nonrotating lead screw, or shifted to drive the sleeve through a five-step gear reduction train.

Direct drive to the sleeve gives rapid advance. The gear reduction gives the drilling feed. Nuts are engaged or disengaged from the leadscrew by a ring which is shifted axially by a solenoid. A limit switch operated by the advancing tool spindle de-energizes the solenoid to disengage the nuts and let the springs return the spindle. Shift from rapid advance to controlled feed is also made by a limit-switch-controlled solenoid.

The unit is made by Hole Engineering Service, Detroit, Mich.



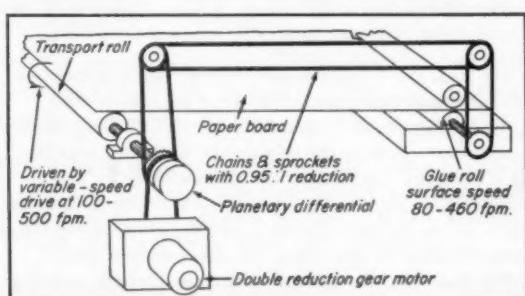
GEAR TRAIN is shown removed from housing.



**PLANETARY DIFFERENTIAL** made from a shaft-mounted speed reducer by driving the normally-fixed torque disc, using the output member as the input member, and adding a sprocket to allow slower speed output than the usual belt drive.

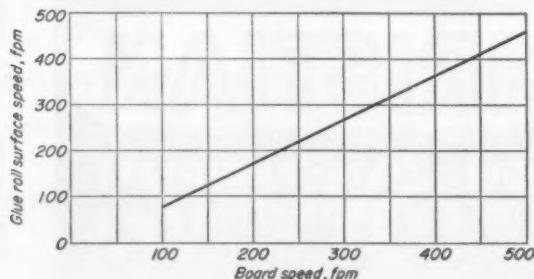
### **Speed reducer acts as differential**

**SIMPLE MODIFICATIONS** to a shaft-mounted speed reducer produced a differential for the glue roll drive on a paper board corrugating machine. The drive runs the glue roll so its surface speed is related to the sur-



#### **SCHEMATIC of glue roll drive.**

**SPEED REQUIREMENT** for the glue roll on a paper board corrugating machine is somewhat unusual.



$$\text{face speed of the paper board passing over it by } s_g = 0.95 s_b - 15 \quad \dots \quad (1)$$

where  $s_g$  = glue roll surface speed, fpm  
 $s_p$  = paper board speed, fpm

$s_b = \text{paper board speed, fpm}$

This equation is shown plotted over the actual paper board speed range of 100 to 500 fpm.

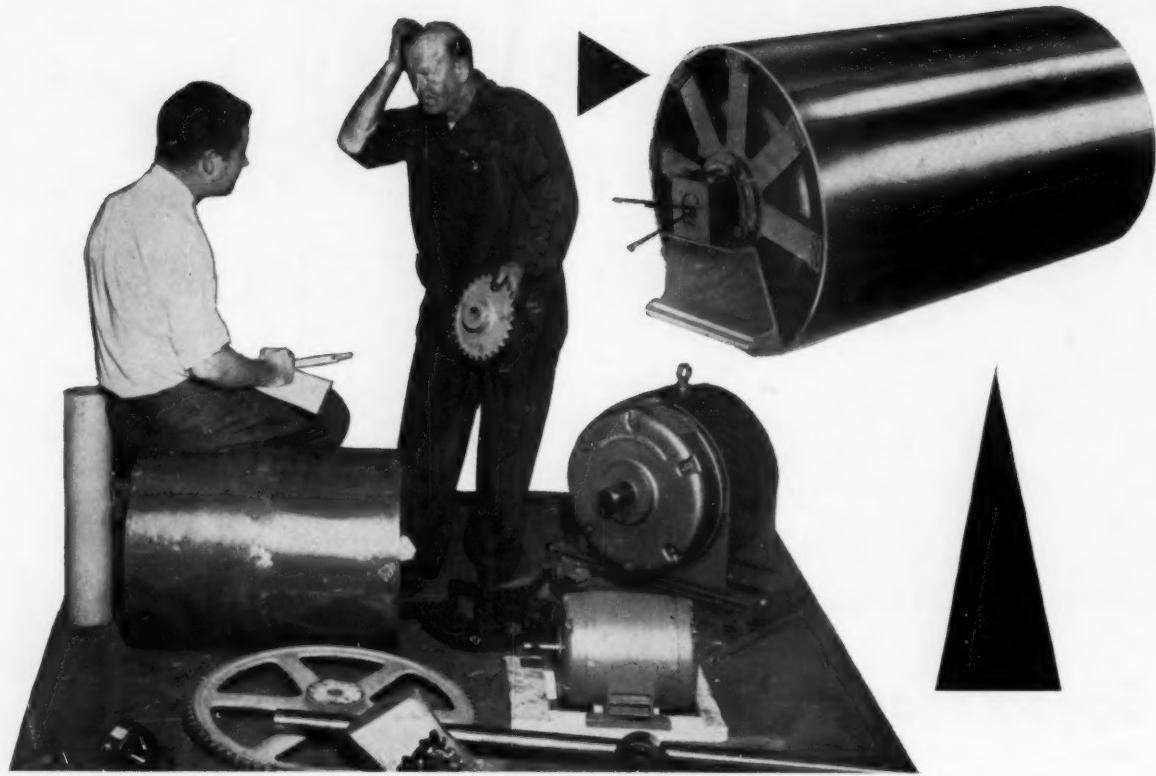
The relationship between paper board and glue roll speed was established by experiment as the optimum for best adhesion of paper board and corrugated medium.

Solution is a planetary spur gear differential plus fixed-ratio speed reduction. One input is from the shaft of one of the paper board transport rolls. The other input is from a separate double-reduction gearmotor through chain and sprockets. Thus, there are two input speeds, the second one of which is a constant 8.8 rpm. Output is taken from a sprocket attached to the housing.

The differential is therefore a workable conversion of the speed reducer. Cross-sectional sketch of the speed reducer after modification is shown. The torque disc which is normally fixed was made into a sprocket and serves as one of the input members. The housing to which the output sprocket is attached is grooved for V-belts and was originally the input member.

Chain drive from the differential to the glue roll incorporates the fixed reduction ratio of 0.95:1. Although this is not quite the correct solution because the reduction should be performed before the subtraction, the error involved is 1% or less over the range of 100 to 500 fpm.

This installation was made by and is in use at *Cornell Paperboard Products Co.*, Milwaukee, Wis.



**With Christmas toys —  
or belt conveyor drives**

# **DO-IT-YOURSELF- KITS ARE NEVER CHEAPER**

**May we send you Bulletin  
PPT-59 or have our repre-  
sentative call?**

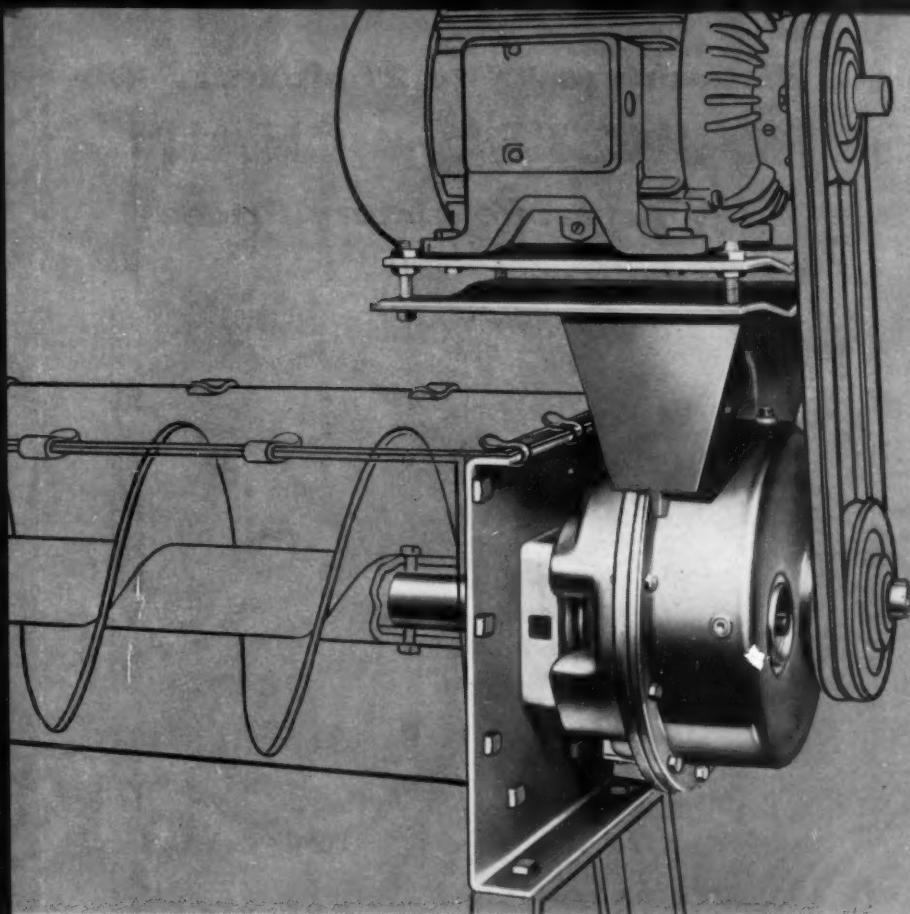
We have all had the experience of following simple (?) printed instructions and putting together a do-it-yourself-toy at Christmas. The usual frustrating experience: . . . instructions so simple, they can't be followed . . . always a screw, a bolt, or a nut missing . . . usually looks good though after we've put it together the second time. (Things never go together right the first time.) At Christmastime we laugh . . . Good thing, we say, that our time is free.

But when time is not free, do-it-yourself-kits can be mighty expensive. For the buyer of the average belt conveyor drive, they usually spell trouble. The average kit consists of 14 separate component parts detailed by an engineer, purchased by a purchasing agent, gathered together and packaged as a drive by mechanics; the responsibility for the whole assembly divided to engineering, purchasing, factory, to motor suppliers, gear men, pulley builders, bearing people. How utterly simple it is to put the responsibility in one place for the simplest drive in the world, the PPT. Motor, gear reduction, backstop are all included within the space of the pulley itself in a single, self-aligning unit held to the conveyor frame with only four bolts. PPT's use standard motors (you may choose your brand), have helical gearing throughout, and are the result of ten years of intensive field applications and tests.

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**REMOVABLE DRIVE SHAFT:** Snap ring assembly permits easy removal. Five sizes, from 1½" to 3½".

**TRough END:** Can be fastened to any standard trough. Eight sizes, from 6" to 20".

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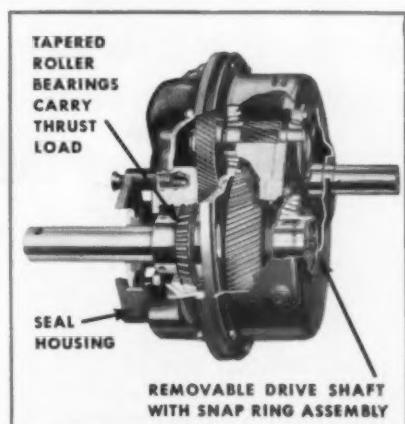
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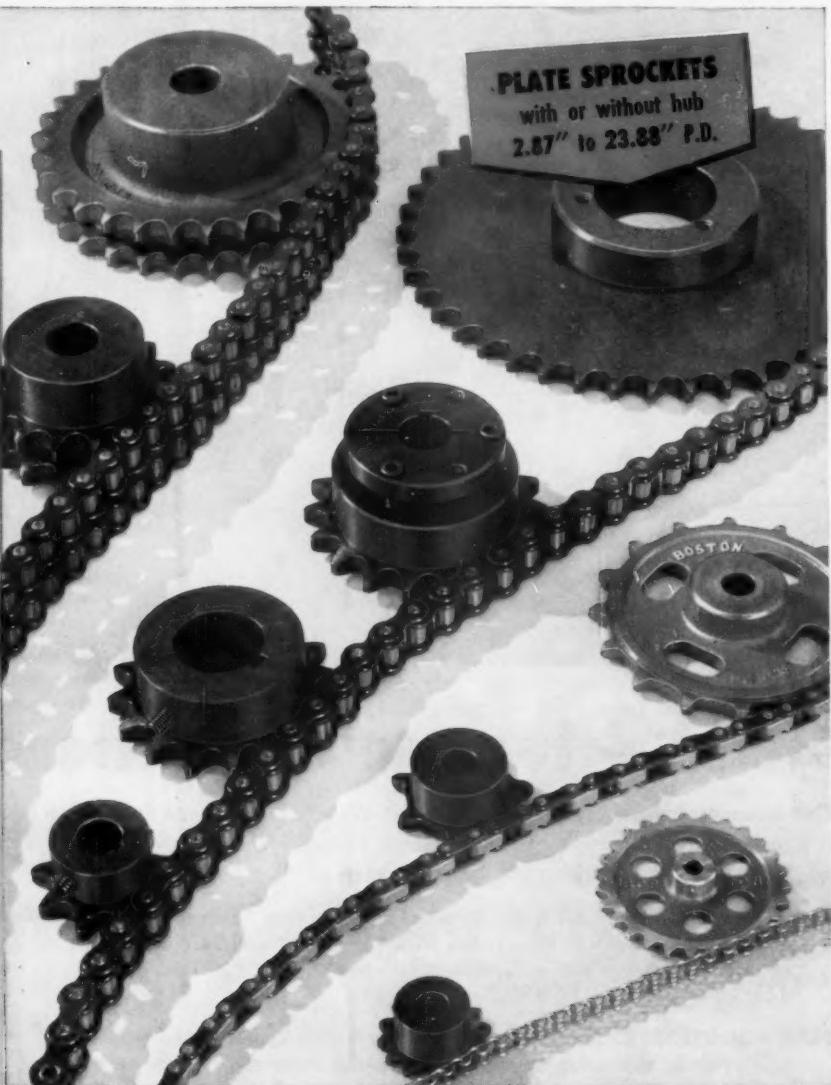
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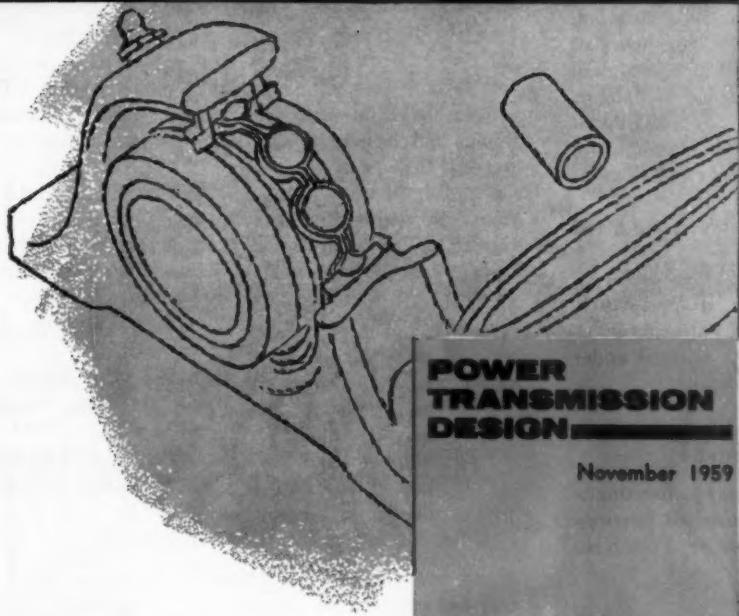
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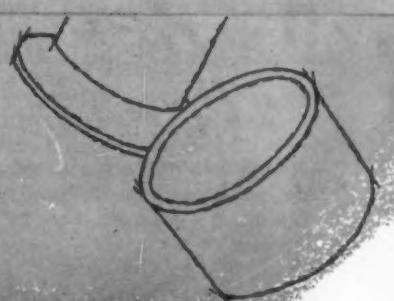
# **BEARINGS**

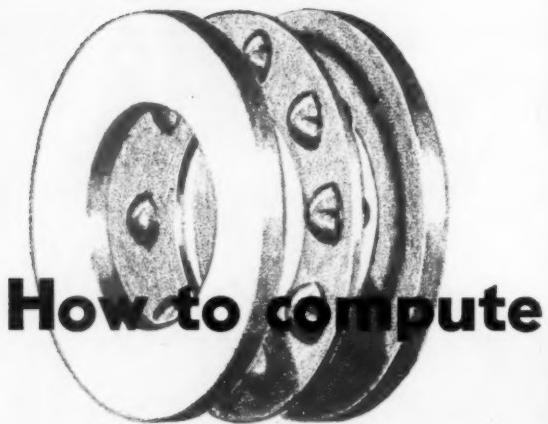
**DESIGN / APPLICATION**



November 1959

**REGULAR MONTHLY  
SECTION OF IDEAS  
AND DEVELOPMENTS**





## How to compute

### ...for ball thrust bearings

**Life** of a thrust ball bearing is defined as the number of revolutions (or hours at some given constant speed) which the bearing will run before first evidence of fatigue in material of either washer or any of the rolling elements.

**Rating life** of a group of identical thrust ball bearings is the number of revolutions (or hours at some given constant speed) that 90 per cent will complete or exceed before first evidence of fatigue.

**Basic load rating** is that constant, central thrust load which a group of identical thrust bearings will endure for a rating life of one million revolutions of one washer.

Load ratings, if given for specific speeds, are based on a rating life of 500 hours.

**Equivalent thrust load** is defined as that constant, central purely axial load which, if applied to a bearing with rotating shaft washer and stationary housing washer, will give the same life as attained under actual conditions of load and rotation.

#### Basic Load Rating Formula

Magnitude of the basic load rating  $C_a$ , for single-row, single- and double-direction thrust ball bearings with balls not larger than 25.4 mm or 1 inch in diameter is

$$\text{for } \alpha=90 \text{ deg} \\ C_a=f_c Z^{2/3} D^{1.8} \quad (1)$$

for  $\alpha \neq 90$  deg

$$C_a=f_c(\cos\alpha)^{0.7} \tan\alpha Z^{2/3} D^{1.8} \quad (2)$$

With balls larger than 25.4 mm in diameter when kilogram and millimeter units are used

for  $\alpha=90$  deg

$$C_a=f_c Z^{2/3} 3.647 D^{1.4} \quad (3)$$

for  $\alpha \neq 90$  degrees

$$C_a=f_c(\cos\alpha)^{0.7} \tan\alpha Z^{2/3} 3.647 D^{1.4} \quad (4)$$

With balls larger than 1 inch in diameter when pound and inch units are used

for  $\alpha=90$  degrees

$$C_a=f_c Z^{2/3} D^{1.4} \quad (5)$$

for  $\alpha \neq 90$  degrees

$$C_a=f_c(\cos\alpha)^{0.7} \tan\alpha Z^{2/3} D^{1.4} \quad (6)$$

where

$D$ =ball diameter

$Z$ =number of balls in single row, single direction bearing

$f_c$ =factor which depends on units used, geometry of the components, accuracy of parts made, and material

$\alpha$ =nominal angle of contact, is angle between line of action of ball load and plane perpendicular to bearing axis

*Continued on page 46*

# dynamic load ratings



...for roller thrust bearings

**Life** of a thrust roller bearing is the number of revolutions (or hours at some given constant speed) which the bearing runs before first evidence of fatigue in either washer or any of the rolling elements.

**Rating life** of a group of apparently identical thrust roller bearings is the number of revolutions (or hours at some given constant speed) that 90 percent of the bearings will complete or exceed before first evidence of fatigue.

**Basic load rating** is that constant, central thrust load which a group of apparently identical thrust roller bearings can endure for a rating life of one million revolutions of one of the bearing washers.

Load ratings, if given for specific speeds, are based on a rating life of 500 hours.

**Equivalent thrust load** is that constant, central, purely axial load which, if applied to a bearing with rotating shaft washer and stationary housing washer, would give the same life as that which the bearing will attain under actual conditions of load and rotation.

## Basic Load Rating Formula

The magnitude of basic load rating  $C_a$ , for single-row, single- and double-direction thrust roller bearings is, for  $\alpha = 90$  deg.

$$C_a = f_c l_{eff}^{7/9} Z^{3/4} D^{29/27} \quad (1)$$

for various degrees of  $\alpha$

$$C_a = f_c (l_{eff} \cos \alpha)^{7/9} \tan \alpha Z^{3/4} D^{29/27} \quad (2)$$

where

$D$  = roller diameter (mean diameter of tapered rollers)

$Z$  = numbers of rollers in a single-row, single-direction bearing. If several rollers are located on one common roller axis, rollers are considered as one roller of length equal to the total effective contact length of the several rollers. This is for rollers that contact same washer raceway area and belong to one row.

$f_c$  = factor depending on units used, exact geometrical shape of load-carrying surfaces, accuracy to which various bearing parts are made, and material.

$l_{eff}$  = effective length of contact between one roller and that washer where contact is shortest (over-all roller length minus roller chamfers, or minus grinding undercuts).

$\alpha$  = angle of contact, the angle between the line of action of the roller resultant load and a plane perpendicular to the bearing axis.

Continued on page 49

TABLE 1  
Factor  $f_c/f$

$D^*$	$f_c/f$	$D \cos \alpha^*$	$f_c/f$	$d_m$	$\alpha = 90 \text{ deg}$	$d_m$	$\alpha = 45 \text{ deg}$	$d_m$	$\alpha = 60 \text{ deg}$	$d_m$	$\alpha = 75 \text{ deg}$
0.01	0.374	0.01	0.429	0.399	0.381						
0.02	0.461	0.02	0.527	0.490	0.468						
0.03	0.521	0.03	0.594	0.553	0.527						
0.04	0.568	0.04	0.645	0.600	0.572						
0.05	0.607	0.05	0.686	0.639	0.609						
0.06	0.641	0.06	0.720	0.670	0.639						
0.07	0.671	0.07	0.749	0.697	0.665						
0.08	0.699	0.08	0.774	0.720	0.687						
0.09	0.724	0.09	0.795	0.740	0.705						
0.10	0.747	0.10	0.812	0.756	0.721						
0.12	0.789	0.12	0.840	0.782							
0.14	0.827	0.14	0.858	0.798							
0.16	0.860	0.16	0.868	0.808							
0.18	0.891	0.18	0.872	0.812							
0.20	0.920	0.20	0.871	0.811							
0.22	0.947	0.22	0.866								
0.24	0.972	0.24	0.856								
0.26	0.993	0.26	0.844								
0.28	1.02	0.28	0.829								
0.30	1.04	0.30	0.811								
0.32	1.06										
0.34	1.08										

\* $d_m$  = pitch diameter of ball set.

TABLE 3  
Values of  $f_c/f$

$D^*$	$f_c/f$	$D \cos \alpha^*$	$f_c/f$	$d_m$	$\alpha = 90 \text{ deg}$	$d_m$	$\alpha = 50 \text{ deg}$
0.01	0.18	0.01	0.19				
0.05	0.25	0.05	0.26				
0.10	0.30	0.10	0.30				
0.15	0.33	0.15	0.31				
0.20	0.35	0.20	0.31				
0.25	0.36	0.25	0.30				
0.30	0.38						

\* $d_m$  = pitch diameter of roller set.

#### ... for ball thrust bearings

Values of  $f_c$  are obtained by multiplying the value of  $f_c/f$  from Table 1 by factor  $f$ .

Recommended value of  $f$  based on current tests of thrust ball bearings of good quality, hardened ball bearing steel is

$f=10$  for kilogram and millimeter units

$f=7450$  for pound and inch units

Magnitude of the basic load rating  $C_a$  for thrust ball bearings with two or more rows of similar balls carrying load in the same direction is

$$C_a = (Z_1 + Z_2 + \dots + Z_n) \left[ \left( \frac{Z_1}{C_{a1}} \right)^{10/3} + \left( \frac{Z_2}{C_{a2}} \right)^{10/3} + \dots + \left( \frac{Z_n}{C_{an}} \right)^{10/3} \right]^{-3/10} \quad (7)$$

where

$C_{a1}, C_{a2}, \dots, C_{an}$  = basic load rating per row of one-direction, multi-row thrust bearing, each calculated as a single-row bearing with  $Z_1, Z_2, \dots, Z_n$  balls respectively

TABLE 2  
Factors X and Y

Bearing type	Single-direction bearings		Double-direction bearings*		$e$
	$\frac{F_a}{F_r} > e$	$\frac{F_a}{F_r} \leq e$	$\frac{F_a}{F_r} > e$	$\frac{F_a}{F_r} \leq e$	
Thrust ball bearings with contact angle:†					
$\alpha = 45 \text{ degrees}$	0.66	1	1.18	0.59	0.66
$\alpha = 60 \text{ degrees}$	0.92	1	1.90	0.54	0.92
$\alpha = 75 \text{ degrees}$	1.66	1	3.89	0.52	1.66

\*Double-direction bearings are presumed to be symmetrical.

†For  $\alpha = 90 \text{ deg}$ ;  $F_r = 0$  and  $Y = 1$ .

TABLE 4  
Factors X and Y

Bearing type	Single-direction bearings		Double-direction bearings*		$e$
	$\frac{F_a}{F_r} > e$	$\frac{F_a}{F_r} \leq e$	$\frac{F_a}{F_r} > e$	$\frac{F_a}{F_r} \leq e$	
Self-aligning and tapered thrust roller bearings					
$\alpha + 90 \text{ deg}$ †	$\tan \alpha$	1	$1.5 \tan \alpha$	0.67	$\tan \alpha$
					$1.5 \tan \alpha$

\*Double-direction bearings are presumed to be symmetrical.

†For  $\alpha = 90 \text{ deg}$ ;  $F_r = 0$  and  $Y = 1$ .

$Z_1, Z_2, \dots, Z_n$  = number of balls in respective rows of one-direction, multi-row bearing

Approximate magnitude of the rating life  $L$  is

$$\left( L = \frac{C_a}{P_a} \right)^3 \text{ million revolutions} \quad (8)$$

where

$P_a$  = equivalent thrust load

Magnitude of the equivalent thrust load  $P_a$  for thrust ball bearings with  $\alpha \neq 90 \text{ deg}$  under combined constant thrust and constant radial loads is

$$P_a = X F_r + Y F_a \quad (9)$$

where

$F_a$  = thrust load

$F_r$  = radial load

$X$  = radial factor

$Y$  = thrust factor

Values of  $X$  and  $Y$  are given in Table 2.

Standards of washer raceway radii are limited to bearings whose raceways have a cross-sectional radius not larger than 54 percent of the ball diameter.

Basic load rating is not increased by use of smaller groove radii, but is reduced by the use of larger radii.

▲▲▲

#### ...for roller thrust bearings

Recommended value of factor  $f$  based on tests of thrust roller bearings of good quality, hardened roller bearing steel is

$f = 56.2$  for kilogram and millimeter units

$f = 49,500$  for pound and inch units

Roller bearings vary considerably in design and execution. Small differences in the relative shape of contacting surfaces may account for differences in load-carrying capacity. It is not possible to give detailed information about exact basic load rating of a given general type of thrust roller bearing.

The approximate basic load rating of a thrust roller bearing may be obtained by use of  $f_c/f$  values in Table 3.

Actual basic load ratings of different bearing types and executions may differ from the values indicated. A bearing must be expected to have a lower carrying capacity when, under load, more or less accentuated stress concentration in the roller contacts are present (point contact) or are not effectively prevented (sharp corners or rigid bearing design). For no bearing type or execution will the factor  $f_c/f$  exceed the value indicated by more than 7 percent.

The magnitude of basic load rating  $C_a$  for thrust rollers, carrying load in the same direction is

$$C_a = (Z_1 l_{eff1} + Z_2 l_{eff2} + \dots Z_n l_{effn}) \\ \left[ \left( \frac{Z_1 l_{eff1}}{C_{a1}} \right)^{9/2} + \left( \frac{Z_2 l_{eff2}}{C_{a2}} \right)^{9/2} + \left( \frac{Z_n l_{effn}}{C_{an}} \right)^{9/2} \right]^{-2/9} \quad (3)$$

where

$C_{a1}, C_{a2}, \dots C_{an}$  = basic load rating per row of one-direction multi-row thrust roller bearing, each calculated as a single-row bearing with  $Z_1, Z_2, \dots Z_n$  rollers respectively

$Z_1, Z_2, \dots Z_n$  = number of rollers in respective rows of one-direction, multi-row bearing

The approximate magnitude of rating life  $L$  is

$$L = \left( \frac{C}{P_a} \right)^{10/3} \text{ million revolutions} \quad (4)$$

where

$P_a$  = equivalent thrust load

Magnitude of equivalent thrust load  $P_a$  for thrust roller bearings with  $\alpha = 90$  degrees under combined constant radial loads is

$$P_a = XF_r + YF_a \quad (5)$$

where

$F_a$  = thrust load

$F_r$  = radial load

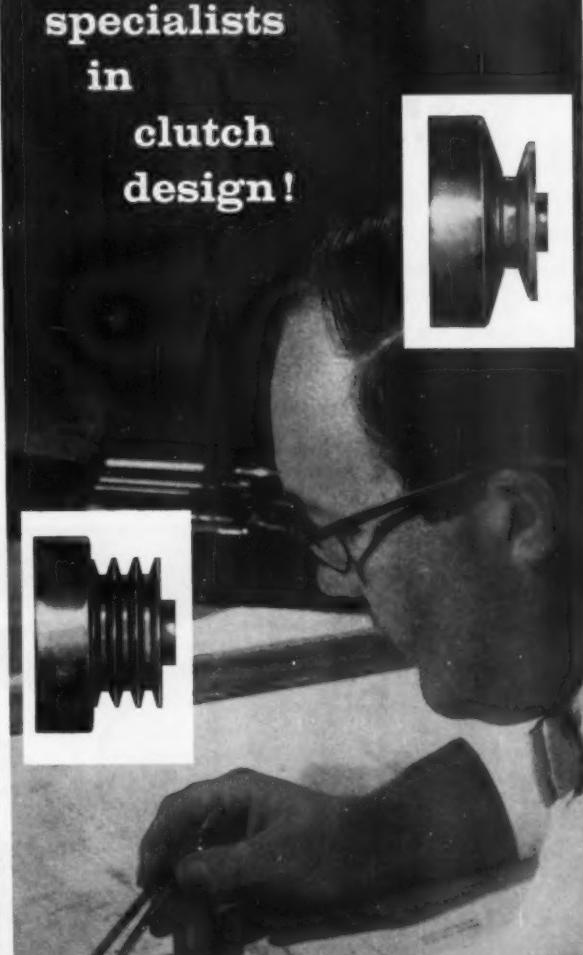
$X$  = radial factor

$Y$  = thrust factor

Values of  $X$  and  $Y$  are given in Table 4.

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MEN continued from page 7



Jacobs

### John Waldron has new general manager

CLEVELAND, OHIO—Robert J. Jacobs is the newly-appointed general manager of the John Waldron Corp., New Brunswick, N. J. and of its Hartig Extruder Div., Mountainside, N. J. Both firms are subsidiaries of Midland-Ross Corp.

Jacobs will be responsible for the Waldron flexible coupling line and paper and foil conversion equipment.



Johnson

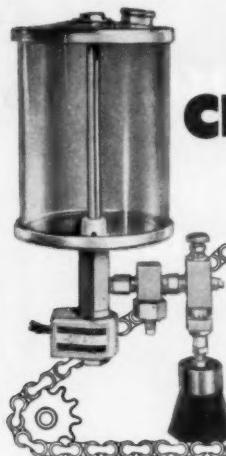
### Johnson is sales aide at Norma-Hoffman

STAMFORD, CONN.—Wayne D. Johnson has been appointed assistant sales manager for Norma-Hoffman Bearings Corp., Stamford, Conn.

Johnson joined the firm in 1956 as a sales engineer covering the upper New York state territory. Prior to his present association he was a project engineer for the Electro-Motive Division of General Motors Corp.



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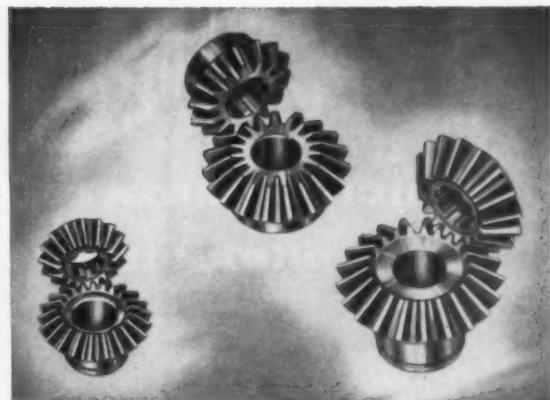


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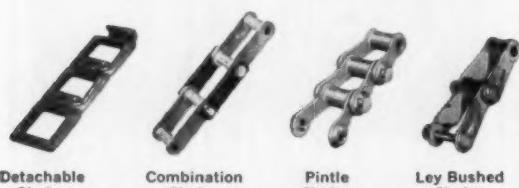
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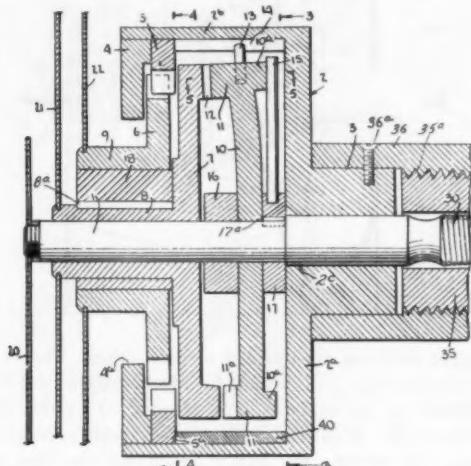
NOVEMBER 1959 / POWER TRANSMISSION DESIGN

## PATENTS

### Step-up, step-down drive

*U. S. Patent No. 2,849,847; Jan Walma, The Hague, Netherlands, assignor to Leendert Prins, Bilthoven, Netherlands.*

Either one of two coaxial output members may be selected by deflecting a toothed disc made of deformable, resilient material.

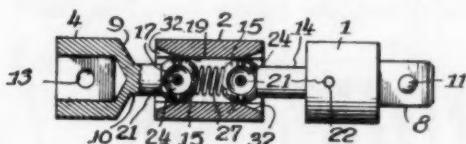


resilient material. As this disc is bent toward one of the output members, the teeth mate with teeth on the output member to drive it.

### Universal joint

*U.S. Patent No. 2,895,314; Tony W. Helm, Chicago, Ill.*

Female member has flat sides which flare out at the ends. Two balls fit inside the female member and are pinned to it. Holes for the pins are approximately



the diameter of the pin at the center of the ball but flare out toward the ball surface to let the balls swing in all directions on the pin. Projections on the surfaces of the balls fit into the corners of the female member to transmit driving force.

*Continued on next page*

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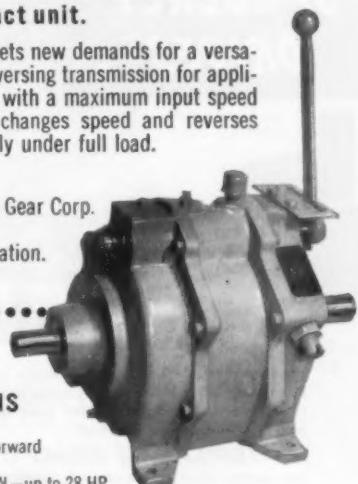
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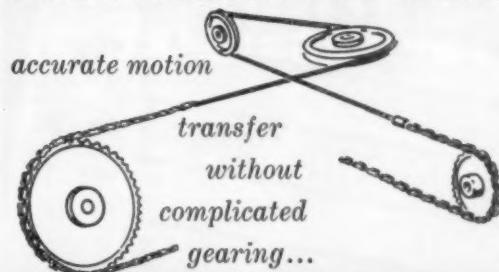
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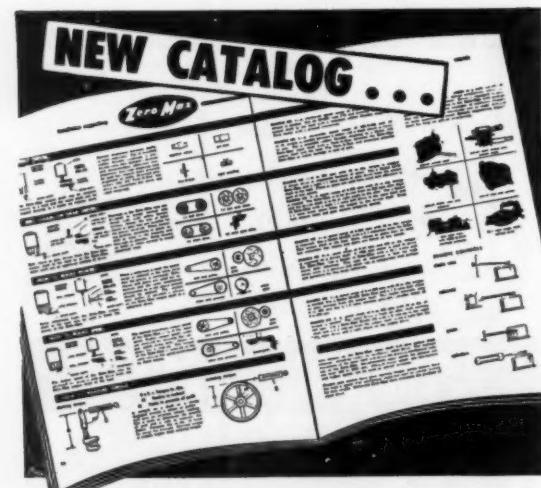


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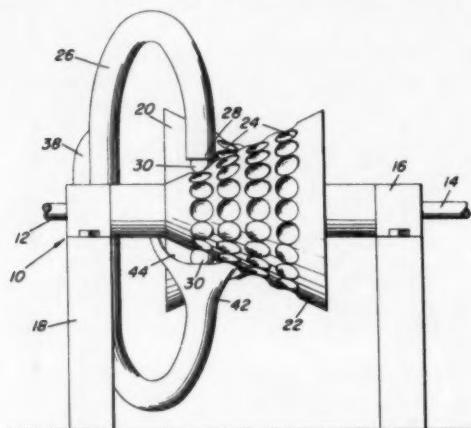
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54

PATENTS continued from preceding page

### Variable-speed drive

U. S. Patent No. 2,869,378; Andrew P. Fisher, Modesto, Calif.

Driving and driven shafts are parallel. A frustoconical member on each shaft has its major diameter aligned with the minor diameter of the other so the

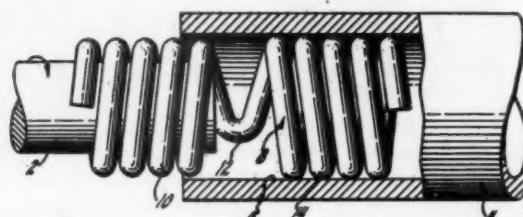


adjacent surfaces are parallel to each other. The two are connected by balls which fit into hemispherical indentations in the surfaces. An external ball guide recirculates the balls and acts as the speed changing means. By moving the ball guide along the line of the adjacent surfaces, balls make the driving connection at different points to vary speed ratio.

### Spring Clutch

U.S. Patent No. 2,895,578; Frank J. Winchell, Franklin Village, Mich., assignor to General Motors Corp., Detroit, Mich.

Designed to transmit power between a solid shaft and a second coaxial tubular shaft, the clutch consists of a spring section wound to fit the solid shaft, a connecting section, and another spring section wound to fit the bore of the tubular shaft. As shown here, clock-

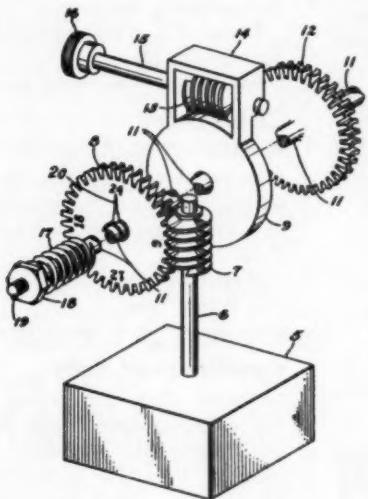


wise rotation of the solid shaft, as viewed from the left end, causes both spring sections to engage their respective members and transmit power. Rotation in the opposite direction disengages the shafts.

## Differential mechanism

*U.S. Patent No. 2,896,476; Winston F. Williams, Cedar Rapids, Iowa, assignor to Collins Radio Co., Cedar Rapids, Iowa.*

In this system, two worm gear sets drive a common output shaft. One set is rigidly coupled to the shaft. The other drives through a plate on the shaft held in contact with the worm gear by a spring. This lets the

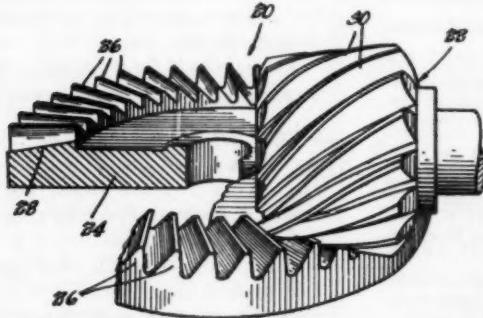


rigidly coupled gear set drive the output shaft even though the other set is stationary since the plate and worm gear can slip with respect to each other.

## Skew axis gearing

*U.S. Patent No. 2,896,467; Oliver E. Saari, Schiller Park, Ill., assignor to Illinois Tool Works, Chicago, Ill.*

Right-angle, skew-axis gears consist of a relatively large face-type gear and mating pinion. The gear has plane teeth which are tangent at their pitch points to the curve which is codirectional with the relative



velocity vector at every point of the pitch contact locus along which pitch surfaces of the gear and pinion contact one another at a point of inflection of the curve. Gear teeth have unsymmetrical pressure angles and the pinion is conjugate to the gear.

*Continued on page 59*

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**PROTECTS** conveyors • elevators • feeders • belt conveyors

**OPERATING SPEEDS** of 10 to 150 rpm make the ROTO-GUARD applicable to automatic protection of slow-moving machinery used in material handling and similar systems

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And a Funk Revers-O-Matic Drive, equipped with torque converter, allows the buggy operator to change direction of travel with foot lever only.

Another example of how FUNK MODULAR POWER UNITS can be economically combined — in an unlimited number of arrangements.

Let FUNK solve your power transmission problem.

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For more information circle No. 1 on Reader Service Card

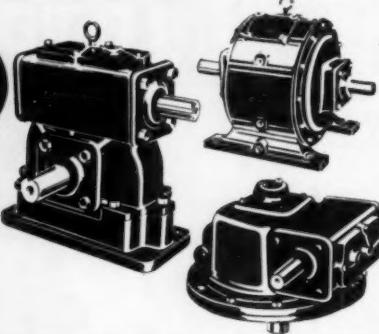


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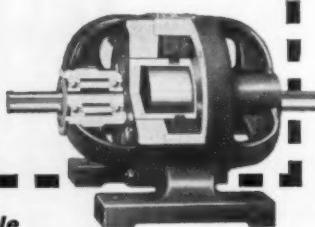
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The Vickers MAGNECLUTCH consists fundamentally of two rotating concentric cylinders coupled by dry magnetic particles under the influence of a magnetic field. With no direct contact between clutching surfaces, there is no wear; life of the MAGNECLUTCH is exceedingly long. Torque is easily regulated by varying the magnetizing coil current.

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The many unique features of MAGNECLUTCHES make them the most versatile and dependable clutches available, whether for tension control, cycling (start-stop) operation, torque limiting, controlled acceleration, wind-up, starting of high inertial loads, or constant torque transmission. Write for Bulletin 6000A



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### Universal joints

Newly-published catalog gives details on single and double universal joints, their selection and care.

*Curtis Universal Joint Co., Inc.*, Springfield, Mass.

Circle number 13 on reader service card

### Clutch-pulley

Benefits of electric motion control from new Electro-Sheave, a pre-engineered, assembled clutch-pulley package. Five sizes, 1 to 25 hp. Bulletin P-52.

*Warner Electric Brake & Clutch Co.*, Beloit, Wisc.

Circle number 42 on reader service card

### Variable-speed belts

Changing pitches, changing centers and changing speeds with belt line gives complete versatility. Triple-tempered belts give highest efficiency. Catalog VSB-1 gives complete selection data.

*Maurey Mfg. Corp.*, Chicago, Ill.  
Circle number 24 on reader service card

### Wedge-type V-belts

Economical and compact, Hy-T Wedge belts are built with extra power and are perfectly matched, can save up to 50 percent in space.

*Goodyear Tire & Rubber Co.*, Akron, Ohio.

Circle number 19 on reader service card

### Gear motors and reducers

Ritespeed models, fractional to 80 hp, ratios to 82:1. Floor, ceiling, wall or vertical mounting styles. Bulletins B-5829, B-5828.

*Crofts U.S.A., Inc.*, Chicago, Ill.  
Circle number 11 on reader service card

### Chain drives

Swivel-like bead chain and non-slip sprockets for low-speed, positive drives at low cost. Specially good for inaccessible locations.

*Bead Chain Mfg. Co.*, Bridgeport, Conn.

Circle number 3 on reader service card

### Clutch line

Bulletin shows typical installations and furnishes capacity table, dimensions, specifications.

*Rockford Clutch Div., Borg-Warner Corp.*, Rockford, Ill.

Circle number 32 on reader service card

## LITERATURE on drives and components

### Stock gears

Popular line includes brass, bronze, steel, semi-steel, cast iron, and non-metallic gears in range of 48 to 3 diametral pitch. Catalog 360 gives detailed information.

*American Stock Gear Div., Perfection Gear Co., Harvey, Ill.*

Circle number 31 on reader service card

### Flexible couplings

Flexring couplings for fractional hp duty. Four stock bores, replaceable center ring.

*Main Engineering & Machine Works, Inc., South Bend, Ind.*

Circle number 23 on reader service card

### Gearbelt drives

Positive action of gears and flexibility of belts are combined, with high mechanical efficiency attained. They engage matching pulleys without metal-to-metal contact.

*Browning Mfg. Co., Maysville, Ky.*

Circle number 7 on reader service card

### Power terminal package

PPT has motor, reduction gearing, backstop, headshaft and headshaft bearings in one package. Bulletin 59 gives information on models and uses.

*J. D. Christian Engineers, San Francisco, Calif.*

Circle number 9 on reader service card

### Steel cable V-belts

Auto AirCon belts for air-conditioning systems in cars have steel pulling cords. Electronic pre-tensioning and special curing method makes them free from vibration, gives them 150 to 250 percent longer life.

*U. S. Rubber Co., New York, N. Y.*

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### AC motors

Dependable motors, 1 to 600 hp in all popular models. Brochure shows full line.

*Brook Motor Corp., Chicago, Ill.*

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### Chain line

Chain is link tested, pitch tested and shock tested before going on the market. Many styles, including detachable, combination, pintle and ley bushed.

*Moline Malleable Iron Co., St. Charles, Ill.*

Circle number 27 on reader service card

### Speed reducers

Over 200,000 combinations possible with double-enveloping worm gear reducers from fractional to 665 hp, ratios from 5:1 to 70:1, wide versatility of mounting choices.

*Cone-Drive Gears, Div. of Michigan Tool Co., Detroit, Mich.*

Circle number 10 on reader service card

### Flexible coupling

Single slab-sided connecting pin construction makes this coupling easy to assemble or disassemble. Only one pin need be connected. All-steel construction extends life expectancy. Catalog CPI-57.

*Acme Chain Corp., Holyoke, Mass.*

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### Multiple V-belts

DA358 belts give more hp in given area, at less cost, and with fewer belts, smaller and lighter sheaves and shorter center distances.

*Durkee-Atwood Co., Minneapolis, Minn.*

Circle number 15 on reader service card

### Honed-gear motors

Superfinished Syncogear motors give extra smoothness, quiet running, longer life through honing of hardened teeth. Hp range is 1/3 to 50. Brochure F-1880.

*U. S. Electrical Motors Inc., Los Angeles, Calif.*

Circle number 39 on reader service card

### Speed reducers

Single, double and triple types with herringbone and helical gearing for ratios from 2.31 to 1 to 429 to 1; worm gear styles from 3.56 to 1 to 10,000 to 1. Catalog 55 gives details.

*Horsburgh & Scott Co., Cleveland, Ohio.*

Circle number 21 on reader service card

Continued on page 60

**Servospeed**  
**HEART OF AUTOMATION**

**MODERN ELECTRONIC ENGINEERING GIVES PRECISE MOTOR SPEED CONTROL**

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Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.

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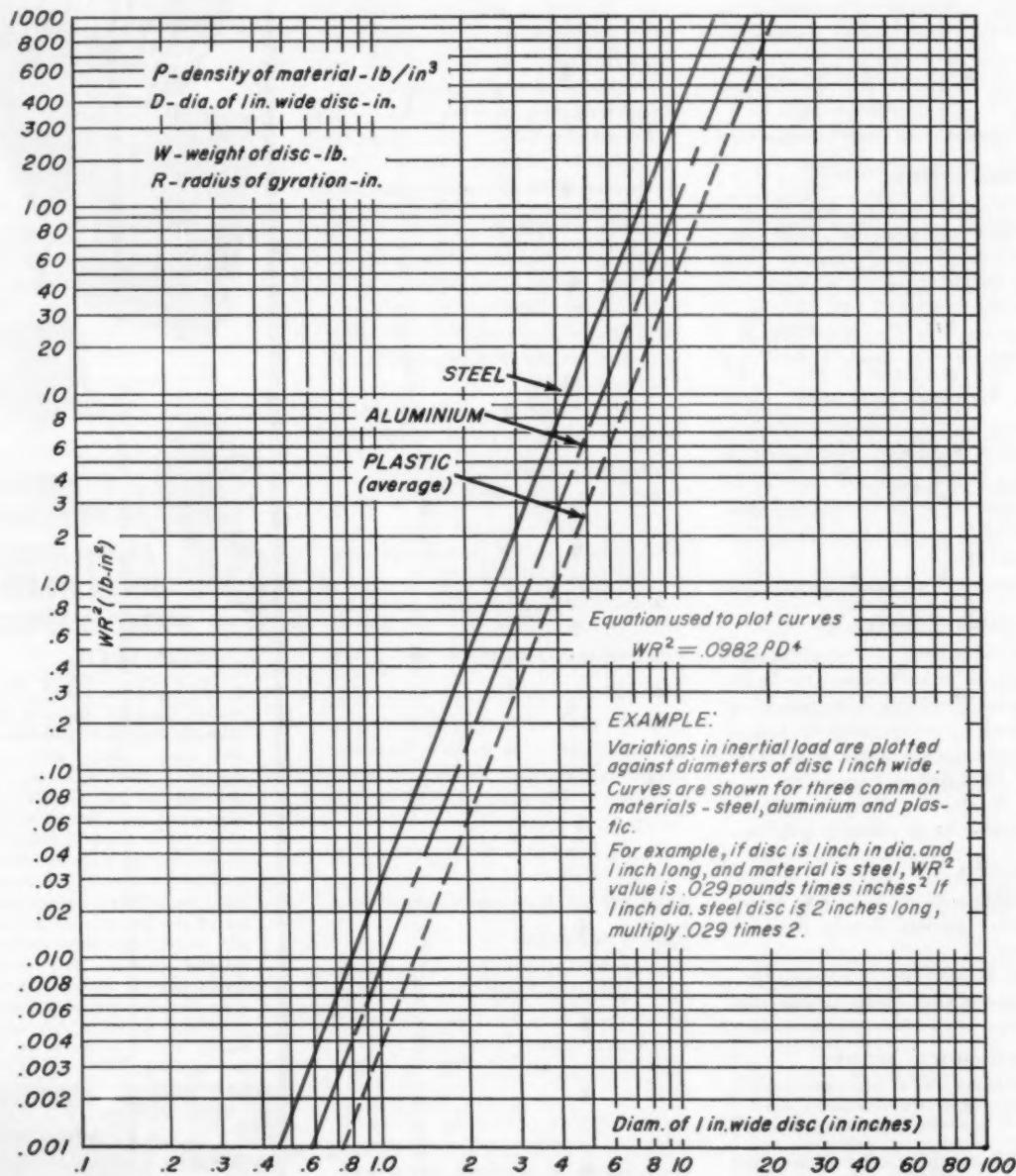
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## REFERENCE FILE

# Nomogram of inertial load variations ... of rotating weight

Courtesy Curtiss-Wright Corporation

### INERTIAL LOAD VARIATIONS



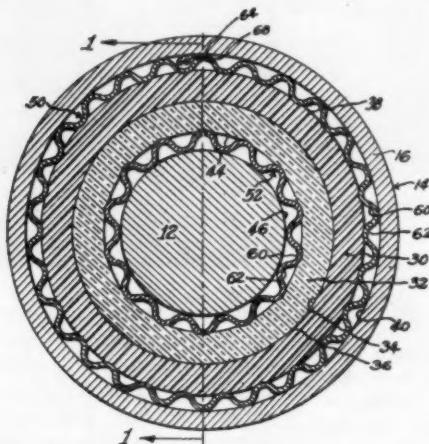
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PATENTS continued from page 55

## Expansion compensating sleeve bearing

U.S. Patent No. 2,897,026; John Haller and Lewis W. Alexander, Northville, Mich., assignors to Halex Corp.

In this nylon sleeve bearing unit, compensation for radial expansion or contraction due to temperature



changes is compensated for by an undulating spring of relatively thin material. The spring maintains a relatively constant clearance between the relatively rotating portions of the bearing. A similar spring is used between the shaft and an inner sleeve.

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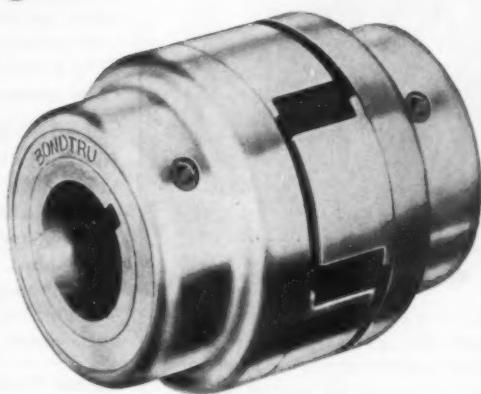
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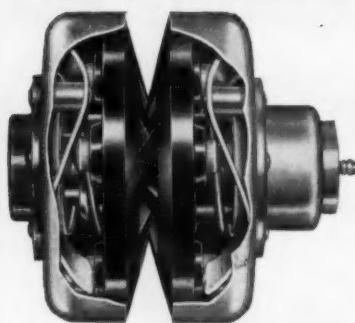
**CHARLES BOND COMPANY**



**617 Arch Street, Phila. 6, Pa.**

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## Hi-Lo Load-O-Matic Control Eliminates Pulley Slow Down



Hi-Lo Variable Speed Pulleys positively maintain the desired speed ratio over a wide range of load variation by means of an exclusive cam and cam follower assembly. This means:

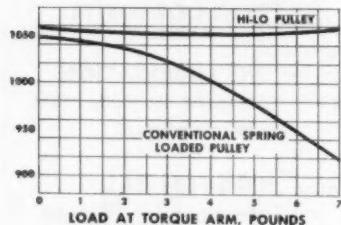
Pulley speed is independent of load and load changes. "Drag" is eliminated and high shock absorbency provided.

Pulleys do not compress belt due to spring pressure. Springs are not driving members. They act only to keep pulley faces in contact with belt.

Pulleys automatically regulate belt tension. Because of the cam assembly, belt is never under more tension than required by the load.

Double cams maintain constant belt alignment.

### HI-LO PULLEYS COMPARED TO OTHER VARIABLE SPEED PULLEYS



#### PLUS THESE OTHER FEATURES:

- Smaller in size than comparable units.
- Quickly and easily installed.
- Replaceable face assemblies drastically cut repair and replacement costs.
- Available in sizes from .5 to 5 hp., ratios to 2.5/1 (single pulley) 6.25/1 (double pulley).

Request details and prices. Ask for Bulletin A-458.

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Chicago 44, Ill.

LITERATURE continued from page 57

### Universal joints

Close-coupled, roller bearing styles for use in spaces where limited clearance does not permit using a flanged joint. Extra flexibility with high safety provisions.

Mechanics Universal Joint Div., Borg-Warner Corp., Rockford, Ill.

Circle number 25 on reader service card

### Speed reducers

Hi-Line fin and fan cooled styles for more capacity in less space. Six series, center distances from 1.33 to 5.25 in., input capacities from 1/16 to 18 hp. Catalog gives engineering data, 65 pages.

Ohio Gear Co., Cleveland, Ohio.

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### Screw conveyor drive

Six sizes for entire range, each with ratios of 4, 9, 14 and 24 to 1. All-steel motor mount can be fastened to any standard trough end. Bulletin 7106.

Falk Corp., Milwaukee, Wisc.

Circle number 16 on reader service card

### Miniature chain, sprockets

Accurate motion transfer without complicated gearing. Unlimited center to center selection for servo, gyro, electronic assemblies, etc. Catalog gives details.

Sierra Engineering Co., Sierra Madre, Calif.

Circle number 35 on reader service card

### Bevel gearing

Straight tooth, helical, spiral, zero-lip styles for wide variety of precision applications. Small gearing guide contains useful charts.

Gear Specialties, Inc., Chicago, Ill.

Circle number 18 on reader service card

### Bronze bearings

2227 sizes cast, sintered oil-filled stock bearings. Engineering handbook and catalog 58 give full specifications.

Bunting Brass and Bronze Co., Toledo, Ohio.

Circle number 8 on reader service card

### Speed reducers

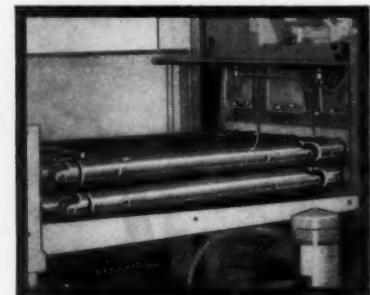
Pocket-sized catalog has information on 75 types of reducers, fractional to 400 hp, ratios to 10,000 to 1.

Abart Gear & Machine Co., Chicago, Ill.

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Continued on page 62

## HOW CURTIS SOLVED A CLOSE CENTER-TO-CENTER PROBLEM



The close center-to-center spacing of these drive spindles on a Sutton-Maust Precision Backed-up Roller Leveler created a tough problem for its manufacturer. He needed a universal joint strong enough to stand up under heavy rolling mill conditions, yet small enough to operate at such close quarters.

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This is just one of the many power transmission problems solved by Curtis universal joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and 40 years' experience manufacturing universal joints exclusively make them that way.

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MICRO has designed and produced millions of worms and gears in an endless variety of styles for all sorts of applications. Their production wise engineers help find important design savings and, their highly tooled machines save money and assure uniform accuracy.

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- Materials:** Steel, cast iron, bronze and special materials.
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- Thread Lead:** Held to .001" per inch of length.

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Throated type worm gear made from continuous cast bronze tubing.



### **Garage Door Operator Drive**

Conventional 24:1 reduction using a 1" PD stress proof steel worm and, 2" PD bronze worm gear.



### **Jalousie Window Operator**

A hardened, cyanide treated, single lead worm with a hardened 1040 treated steel spur gear. Reduction is 20:1.



### **Transmission Overdrive Governor**

This 2:1 reduction drive uses a 2" PD worm and 3/4" PD helical spur gear both made of case hardened steel.



### **Micro Packaging Stops Gear Damage**



In transit or storage this unique packaging system prevents worm and worm gear damage and provides faster, easier handling.

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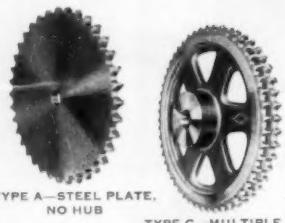
for power transmission

# DIAMOND Roller Chain & Sprockets

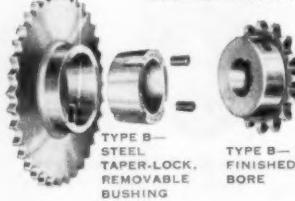
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CHAIN



STOCK  
SPROCKETS



TYPE A—STEEL PLATE,  
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### Variable-speed pulleys

Hi-Lo line keeps speed ratio constant under load variation, balances and protects drive. Bulletin A-458.

*Lovejoy Flexible Coupling Co.,  
Chicago, Ill.*

Circle number 22 on reader service card

### Reversing transmission

5 in 1 model 5231 combines two speeds forward with neutral, reverse and reduction into one compact unit. For applications up to 28 hp, 2000 rpm top input speed.

*Snow-Nabstdt Gear Corp., Hamden, Conn.*

Circle number 36 on reader service card

### Automatic clutches

Catalog BL-1 describes complete line of precision-built, standard clutches with MercoTorque action.

*Mercury Clutch Div., Automatic  
Steel Products, Canton, Ohio.*

Circle number 26 on reader service card

### Roller chain drives

Catalog 51A gives particulars on extensive line of roller chain and accessories, including over 100,000 stock sprockets.

*Cullman Wheel Co., Chicago, Ill.*

Circle number 12 on reader service card

### Variable-speed catalog

16-page booklet shows how to get the most from electric motors: variable speed, instant control, reversing, torque increasing, and other types of controls.

*Zero-Max Co., Minneapolis, Minn.*  
Circle number 43 on reader service card

### Chain oilers

Feed oil by gravity through solenoid and sight feed valve to brush riding the chain. Oiling occurs only when chain is moving. Bulletin shows how to avoid chain breakdown.

*Oil-Rite Corp., Manitowoc, Wisc.*  
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### Modular power units

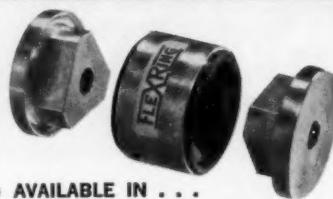
Can be combined economically in an unlimited number of arrangements.

*Funk Mfg. Co., Coffeyville, Kan.*  
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SOUTH BEND 14, INDIANA  
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### Universal joints

Illustrated catalog gives dimensions and suggestions for use of Atlas joints. 15 sizes for all requirements.

*Gray & Prior Machine Co., Hartford, Conn.*

Circle number 20 on reader service card

### Flexible couplings

Aluminum couplings weigh up to 60% less than iron ones, are insulated, self-aligning and require no lubrication. Large stock available.

*Charles Bond Co., Philadelphia, Pa.*

Circle number 5 on reader service card

### Shaft motion indicator

Roto-Guard shows drop in speed or stopping of machinery, gives protection to slow-moving machinery. Bulletin RG-16.

*Bin-Dicator Co., Detroit, Mich.*  
Circle number 4 on reader service card

### Simplified sheaves

QD (quick detachable) sheaves are easily installed, assure permanent alignment.

*Worthington Corp., Oil City, Pa.*  
Circle number 44 on reader service card

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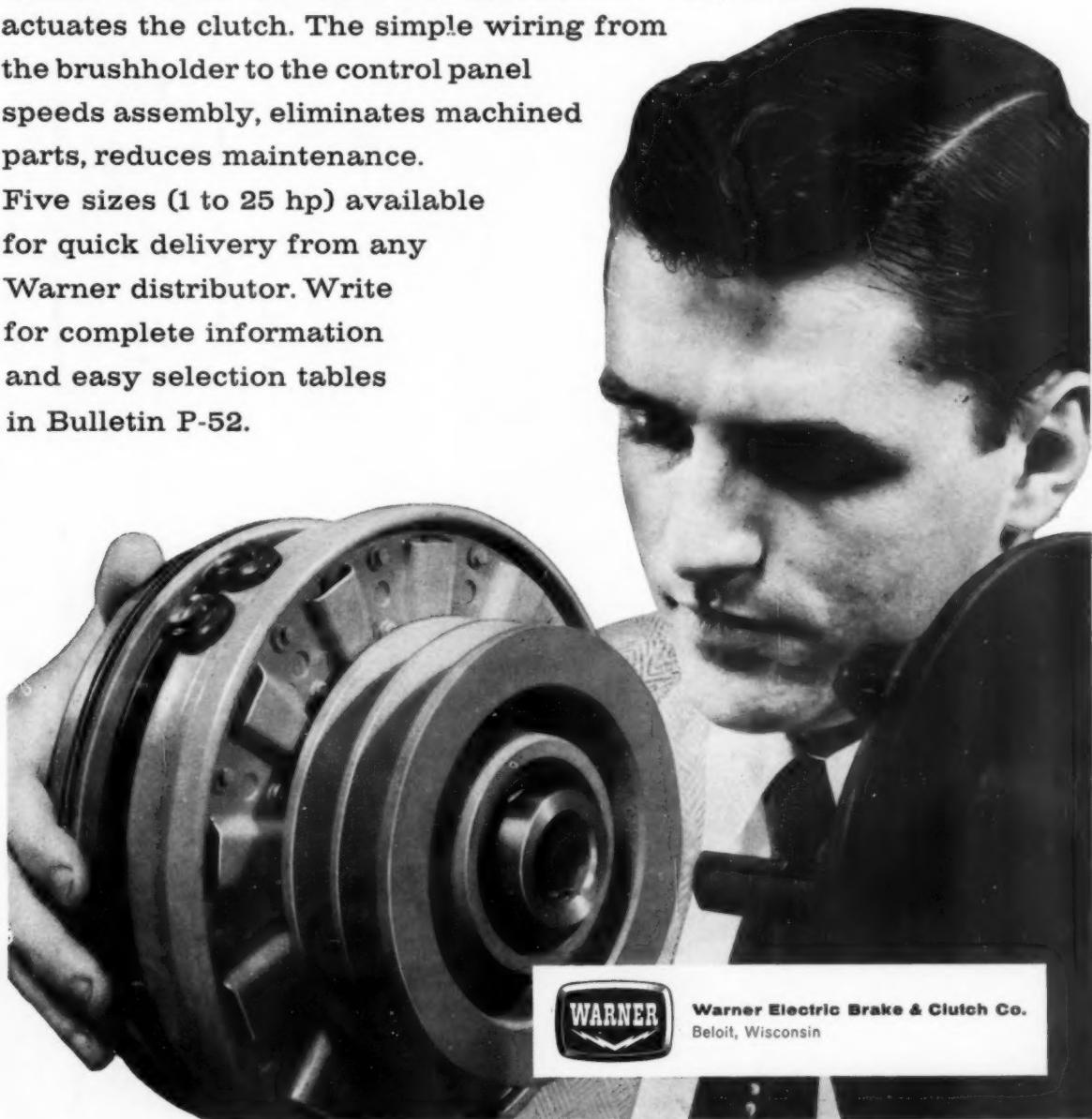
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Beloit, Wisconsin

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